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THE ORGANIZATION OF AGRICULTURE AND THE SCIENCES IN THE HIGH SCHOOL

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JOSIAH MAIN
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THESIS

Submitted in Partial Fulfillment of the Requirements for the

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I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

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THE ORGANIZATION OF AGRICULTURE AND THE SCIENCES IN THE HIGH SCHOOL.

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I. A Problem in Adjustment.

The proposition to put agricultural courses into the high schools may seem, at first thought, to be merely one of adding another subject to the curriculum. But experience shows that a curriculum may not be treated so arbitrarily. It is necessary that study be made of this subject and, more especially, of the adjustment of this to other high school subjects.

The subjects of the present curriculum most concerned in this adjustment are the sciences. These, "the most precious achievement of the race,"[1] are themselves comparatively new to the curriculum and the promise with which their introduction into the school was made has fallen far short of fulfillment so that at present their status is far from a final adjustment.[2,3] And their close relation to the new subject, agriculture, makes the problem of adjustment of all a single problem.

The strength of the agriculturists' argument for the inauguration of courses in the schools has usually been the immense economic significance. But the successful teaching of agriculture in the school along with the traditional courses depends, as they all do, upon its being regarded and developed as a humanistic subject as well. It will have to "make good" pedagogically if it is to have a permanent place.[4,5] But it is also likely that pedagogy will

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[1] Hall; Adolescence, vol. ii. p. 544.

[2] Butler; address of welcome to American Association for the Advancement of Science. 1900

[3] Ganong; Botanical Education in America. A.A.A.S. 1903.

[4] Bagley; The Educative Process, pp. 5, 40.

[5] Abbey; Normal School Instruction in Agriculture, p. 3.

have to recognize some new educational values before the subject can be considered in good standing. When educational ideals include the highest ideals of social efficiency there will be no higher ideals conceivable and the economic will, of course, be included. Until there is such unity there will be danger of the industrial reform getting in the way of educational progress to the ultimate detriment of both.

A usable pedagogy is necessary to the solution of this problem. If pedagogy does not afford the principles and terms with which to treat the subject it is a sign that we need a new pedagogy.[1,2] Those who seek unity in education should insist that the science of education proceed to attack the problem with such means as it possesses. The result may be worth as much to education as to agriculture.

Left to itself without guiding principles the common mistake regarding this subject is to suppose that agricultural materials have inherent qualities which determine how they should be marshalled in the course. The result is the confusing variety of mechanically graded courses which certain catalogues present.[3] As a matter of fact any purely agricultural theme will have phases which might make it an appropriate subject for any grade. The thesis here maintained is that the child's mind and body, rather than the materials, are the variable factors that should determine all courses of study and that in the high school these must first determine the organization of the sciences.[4] For the only features

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[1] Carlton: Education and Industrial Evolution, pp. 3, 18.
[2] Davenport: Education for Efficiency, pp. 46, 90.
[3] Brown: The Making of our Middle Schools, p. 440.
[4] Canong: Botanical Education in America.

of agriculture that have pedagogic cohesion are the sciences involved.

Left to itself without any practice in its utilization, high school science has not kept pace with educational needs. The fault is that the student has been held too rigidly to the accuracy of an accumulated knowledge with too little experience in the method of acquiring it.[1,2] Pure science cannot be appreciated by the adolescent who still retains his childish interest in the use of things.[3,4,5,6] And if it could be taught as pure science its destructive tendency, striking as it does at the root of authority, is of questionable propriety where it does not at the same time furnish a philosophy of life.[7] It is especially necessary under a rational government that it be made humanistic.[8,9]

The purposes of high school agriculture, therefore, await the reform of the high school sciences and that a reform in the direction of applied science is necessary is evident to many science teachers who have no special interest in agriculture. The biologists, especially, are gravitating toward the familiar things with which agriculture must deal. If the agriculturists do not take advantage of this it will be their own fault. For if the scientists are to assume that part of the burden for the sake of the sciences such loss of jurisdiction should not be taken amiss by the agriculturists, who may rest assured that there is no means of cheating

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[1] Dewey: Science as Subject-matter and as Method.
[2] Eliot: Education for Efficiency, pp. 36, 37.
[3] Barnes: A Study of Children's Interests, p. 210.
[4] Bagley: The Educative Process, p. 73.
[5] O'Shea: Dynamic Factors in Education, p. 41.
[6] Hall: Adolescence, vol. ii. p. 65.

[7] O'Shea: Education as Adjustment, p.
[8] Brown: The Making of our Middle Schools, p463.
[9] Carlton: Education and Industrial Evolution, p. 269

nature so as to achieve their scientific results without thereby doing that which is best for agriculture.[1] Only in making the two phases of work complementary is agriculture securing a permanent place in the course. It may be that keeping the two interests uncorrelated[2] will not only result in the decadence of high school science but will also keep the subject of agriculture pedagogically outside the course of study however much effort may be used to keep it in.[3]

Agriculture in the high school will bear one of three relations to the fundamental sciences, namely, it will be taught before related science is taught, or while it is being taught, or after it has been taught.

The success of agriculture in the high school depends upon its being made of such dignity as to challenge the powers of the best students. And the best students will not be attracted to a subject that is long kept in its elementary stages.[4] There is more to lose than to gain in attempting to popularize the subject by writing all of the science out of it. If it is not based upon the fundamental sciences it is not secondary but elementary and as such ignores the genetic stages of development usually represented by the high school adolescent.[5, 6] Therefore, if agriculture is to be made a secondary school subject it must be put on a secondary plane - that is, it must be made scientific[7] by utilization of the

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[1] Brown: The Making of our Middle Schools, p. 438.
[2] Abbey: Normal School Instruction in Agriculture, p. 29.
[3] Bailey: The Nature-Study Idea, pp. 78. 132, 153.
[5] Harris: Educational Creeds of the Nineteenth Century, pp. 39-40.
[6] Bagley: The Educative Process, p. 255.
[7] Carlyle: Sartor Resartus, pp. 206-207.
[4] Hodge: Nature Study and Life, p. 23.

fundamental sciences.[1,2]

The deferring of the agricultural work in the high school until after the underlying sciences have been mastered will be at the very imminent risk of starving the peculiar vocational interest upon which its success depends.[3,4] Investigations as well as experience show that the interest in vocations is born in adolescence[5,6] and that the manual vocations normally precede the others.[7] It is a maxim of education that to develop a useful instinct it should be exercised and directed during the nascent period.[8] However judicious and far-sighted the plans of the teacher may be regarding the student's course, neither the student nor his parents may safely be left indefinitely in the dark regarding them. The average student in the high school should see a generous amount of purpose in all of his work and have the benefit of such experience as is gained only by applying it to its purpose.

Prescribing science work to precede the agriculture means the perpetuation of a form of science teaching that has proven a failure in the high school or it means a reformed kind of science that introduces industrial applications such as many science teachers are advocating.[9] If the latter kind is contemplated it should be unnecessary to provide for it again in the agricultural course, for to admit that it cannot be so utilized is to take all of the mean-

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[1] Davenport: Education for Efficiency, pp. 50, 51.
[2] Brown: The Making of our Middle Schools, pp. 3-4.
[3] Dewey: The School and Society, p. 39.
[4] Eliot: Education for Efficiency, p. 28.
[5] O'Shea: Dynamic Factors in Education, pp. 151-152.
[7] Barnes: A Study of Children's Interests, p. 243.
[8] Kline: A Study in Juvenile Ethics. Ped. Sem., June, 1903, p. 239.
[6] Bagley: The Educative Process, p. 198.
[9] Dewey: The School and Society, p. 37.

ing out of the reform. If the former kind, such pupils as can appreciate pure science may not be expected, after organizing a science in its more perfect form, to profit by an attempt later to open the subject and organize it in a less perfect form for agricultural or other utilitarian purposes, as an addendum loosely attached and unessential, which must deal with drosser materials. The period for such organization is past for the student who can appreciate the science in its more perfect form, while those who might have profited by the compromised science will have been long since eliminated.[1] Thus would both subjects suffer from the divorcement and postponement of agricultural instruction. The conclusion is that agriculture is not supplementary but complementary to the fundamental sciences in the high school.[2]

In the days of pre-evolutionary thought, when learning was all a matter of authority,[3] it was quite natural to think of form as dictating function and formal knowledge monopolized the schools.[5,6] The present conception is that the best teaching is that which does not have the two very far separated in time.[8] In order that the high school science be properly taught it is necessary that the teacher have a ready knowledge of its function and that it be carried to its application[7] while the subject is first being presented to the student and is yet in the formative stage in his mind.

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[1] Bailey:Training for Teachers of Agriculture,p.18.
[2] Abbey:Normal School Instruction in Agriculture,p.29.
[3] Blackstone:Commentaries,Introduction,p.10.
[4] Spencer:Education, omit
[5] Eliot:Education for Efficiency,pp.22-23.
[6] Baldwin:Mental Development,p.64.
[7] Bagley:The Educative Process,p303.
[8] Bailey:The Nature-Study Idea,p.49.

The technique of pure science is the best technique of applied science. The only difficulties which the student og agriculture meets are scientific difficulties. It would be strange indeed if such difficulties might be better dealt with dissociated from the sciences to which they are related.[1,2,3,4,5] The purposes of science, so far as they have any relation, cannot be antagonistic to those of agriculture and it is better for the accomplishment of the reform toward vocational education to let the sciences bear their share of the burden of responsibility.

Should agricultural materials and principles be utilized for the purpose of teaching the sciences and the student progressively pursue his science beyond the ability of agriculture to give any benefit, the operation of constantly reconstructing for the purpose of perfecting the organization is a mental operation quite familiar to educators and is observed in daily practice by good teachers in all subjects. It is the characteristic merit of the "spiral plan" and is generally recognized as the natural order of mental growth. Thus most of the knowledge acquired in school is but transient in its duration - a scaffolding for the erection of a more perfect structure.[6] It is not the agricultural work considered as knowledge so much as the right kind of training in science which its inclusion alone insures that is the best preparation for any college.[7]

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[1] Bagley:The Educative Process, p.233.
[2] Hodge:Nature Study and Life, p.19.
[3] Davenport:Education for Efficiency, p.103.
[4] Huxley:Science and Culture, chap.iv.
[6] Davenport:Education for Efficiency, 76.
[5] Bailey:The Nature-Study Idea, p.138.
[7] Davenport:Education for Efficiency, pp26,71.

But the fundamental sciences cannot be depended upon to give a complete treatment of the subject of agriculture as it should be treated in the high school.[1,2] Where manual skills in technical processes are to be taught or the quality of grosser products studied independent class work must be provided. Then there are certain scientific phases which must be pursued in class further than may be profitable to the science student. Nor can the fundamental sciences be utilized to give sufficient vocational training for the agricultural student. Such training must come largely from students' projects carried on at their homes. But especially is it necessary that agricultural students be segregated late in the course for the treatment of the subject as a whole, where its ideals may be developed and its various phases synthesized into an independent science of agriculture.

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[1] Davenport: Education for Efficiency, p.126.
[2] Editorial: Agricultural Instruction on the Basis of the Pure Sciences, Experiment Station Record, Jan, 1908, p.402.

II. Position of the Various Sciences in the High School Course.

Non-vocational high school studies fall into five groups as heretofore treated, namely, English, foreign language, mathematics, history, and the natural sciences. On these lines of division teachers have specialized in their preparation and they are generally recognized in the instructional division of labor in the school.

Taking each group separately there has been worked out a logical order of presentation, certain phases being regarded as properly coming before or after certain others; the usual test being the dependence of the later or more complex upon the earlier or simpler.

In the case of the science group, where specialization of the subject has probably been carried further than within other groups and a degree of rivalry has developed, the claims of the group as a whole have not, as a result, been strengthened. This rivalry is because the perfection of any phase, as botany, depends upon some knowledge of other phases, as chemistry, which is therefore regarded by the botanist as being important only as it is necessary to a knowledge of botany. The chemist, on the other hand, would reverse the relation of dependence and make the botany subordinate. This interdependence and unity of natural sciences makes it difficult to say what is the best sequence as each partizan would put his favorite in the place of greatest importance to the subject, that is, near the latter part of the high school course where the others which precede it may contribute to its purposes.

Nevertheless a pretty generally accepted sequence of high school sciences has been established by experience. The Famous Report of the Committee of Ten of the National Educational Association, adopted in 1893, has been the most authoritative utterance on this subject though some of its recommendations have not been successful in practice and have been ignored and succeeded by more approved plans. Of the subjects which are in the hands of committees for revision is that of secondary school geography. The proposition is, to put the subject in the first year and broaden it so as to include much more than is comprised in the term "physical geography" which, by the former recommendation, was divided and distributed in various places in the course.[1]

A usual method of compromising conflicting claims of two different sciences has been to divide one of them into two different parts, the elementary being presented early in the course for the benefit of the other science which needs it as a preparatory subject and the more advanced portion being given late in the course where it in turn may have the benefit of those which have preceded it. The Committee of Ten so divided the subject of secondary school geography but their recommendation has not generally been respected. Nevertheless the need of certain portions of physics to prepare for certain portions of physical geography is as great as was regarded by the Committee. And since the subject of physics, by natural growth, has become so large as to require some kind of reorganization in the curriculum, the proposition here is to let this subject be the one to be divided, putting the elementary portion, including what is necessary to other sciences, with the geography

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[1] National Education Association, "Proceedings," 1909. P.820.

of the first year and letting the remainder go over to the latter part of the mathematical group.[1]

This plan makes it feasible to follow the report of the conference on physical sciences which was that chemistry be placed in the third year and physics in the fourth,but which the Committee reversed so that the latter might procede the advanced portions of the physical geography. The reason for the reversal by the Committee being removed,the recommendation of the conference is here looked upon as the more authoritative.

The recommendation of the Committee regarding physiology was that it be placed late in the course. This seems good and it is placed in the last year where it may follow the chemistry,biology, and zoology,with the last of which it is closely related.

The Committee made botany or zoology the second year science, this being the only remaining year in which no science was prescribed and the conference on natural history having expressed no preference as to their places in the course. A study of the courses of the leading high schools shows that this recommendation in the case of botany is more universally observed than is any other recommendation relating to a science subject. If the subject,biology,which it is here proposed to put in the third year,take from botany and zoology those topics which it should cover,it leaves botany a subject easily managed by second or even first yeay students. The zoology is herein made to follow the biology of the third year and to lead directly to the physiology of the fourth year with which vertebrate anatomy naturally merges.

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[1] Hall:Adolescence,vol.ii.pp.155-158.

This unusual position for the subject of zoology, a science which, except for the portion relating to insects, has less significance to industrial students than the others, might be warranted as segregating in the latter part of the course a subject which it may be desirable to omit, for good reasons, from their courses. And it should be remembered that changing the position of any subject in the curriculum implies a change in the character of the subject itself, since it may utilize whatever related matter has preceded it. Thus the unification of science work is best insured by putting electives late in the course and the practice is general, and zoology is more often omitted by students' election than is any other of the subjects mentioned. Entomology should not be an elective by either the agricultural or the science students, being related to the biology on the practical side in the matter of disease and repression. When the value of zoology as a humanistic study in affording development histories, natural selection, parasitism, and evolution - all of which are interpretive of sociological problems and as such must be taught in the high school - is realized, its position late in the course will be better justified.

Interesting data regarding the location of the sciences in the course is shown by the latest published catalogues of Illinois high schools. Of these, twenty-one located in the twenty-one largest cities of the state, outside of Chicago and its environs, give the following averages, all between 0 and 1 signifying a place in the first year, between 1 and 2 in the second, between 2 and 3 in the third, and 3 and 4 in the fourth. The average for each of the

six subjects is as follows:

Physical Geography	.75	Zoology . . .	1.85
Physiology	.94	Chemistry . .	2.95
Botany	1.45	Physics . . .	3.00

The place within the year of a half-year subject is not allowed for in making the record, but a subject is given the value .5, 1.5, 2.5, or 3.5 if be wholly within any one of the four respective years. The science "biology" which appears in a few courses is omitted for lack of information or agreement as to its content.

It is apparent that the natural tendency to vary is restricted by the 0 and the 4 and that averages will tend toward the middle value 2, so that the above result indicates the sequence better than it does the absolute positions of the various subjects.

The figures should also be interpreted in the light of two state laws one of which requires the teaching of physiology in the first year, the few variations from which being to the last year of the course. The other law requires candidates for teachers' first grade certificates to be examined in all of these subjects but chemistry, it being the latest science to invade the high school course. Since these subjects naturally enter the high school course at its upper end, being carried down from the higher institutions, chemistry may be presumed not to have exhausted its natural downward tendency, inasmuch as its progress has been against whatever influence a state law and the recommendation of the Committee of Ten may have.

Of the twenty-one schools physics appears in every course, zoology in 81% of them, the four other subjects being distributed between these limits.

So far, special pains have been taken to conform to authority as expressed in educational deliberations and the common law of good educational practice. If this can be successfully done the changes involved in the introduction of agriculture into the high school will be more in the nature of a reform of the curriculum than of a revolution.

Why should the sciences have taken the arrangement in which they are found in the present high school courses?

Without minimizing the influence of experience in the final formulation of a course, the *laissez faire* policy in the molding of a curriculum is no more satisfactory in the cause of educational progress than it has proven in the case of other man-made institutions. The inertia of educational curricula is proverbial.[1] Authoritative recommendations coming from competent educators may tend to lift subjectd from the rut of bad pedagogy by drawing attention to real and forgotten, or to new educational purposes and the best way to attain them. Such opinions must be based on real needs of the people and so long as leading educators are astute enough to appreciate such needs popular expression of them is unnecessary and educational landmarks are respected. Without attempting to trace origins, we must believe that there are or were good reasons for locating each of the subjects as we find it.

In case of the sciences, the dependence of one upon another could hardly have been a deciding influence for the dependence, where it exists, is mutual. Among influential factors in the ar-

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[1] See references p. 50 on "tendency of education to grow obsolete."

rangement would doubtless be an order of increasing complexity and difficultu,or of scholarship and skill demanded of the teacher,of expense of equipment,and where electives are offered,a tendency to put those of less general application later in the course than the more general.[1] Also,the matter of recency is doubtless a factor inasmuch as the sciences are all new to the course.

But where real competence was influential in the prescribing of general educational policies the psychological needs of the adolescent must have been more potent than any of the mere external motives.[2,3,4] And there could hardly have failed to be a recognition,consciously or unconsciously,of the fact that the learning process with the young involves a great deal of motor reaction in order to vivify the fact,principle,or habit taught,and that this necessity diminishes with advancing years and the accumulation of a stock of experiences with things.[5,6,7,8,9] It is believed that this consideration of motives justifies the arrangement herein presented, but it is incumbent upon the instructor to appreciate and endeavor to realize the purpose,else is any wisdom of arrangement vain.

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[1] De Garmo:Principles of Secondary Education,vol.i.p.35.
[2] Spencer:Education,chap.ii.pp.89-90.
[3] Brown:The Making of our Middle Schools,p.410.
[5] De Garmo:Principles of Secondary Education,vol.i.p.17.
[4] Canong:Botanical Education in America,Science
[6] O'Shea:Dynamic Factors in Education,pp.20,143.
[7] James:Talks to Teachers on Psychology,p.33.
[8] Bagley:The Educative Process,p.196.
[9] Hall:Adolescence,vol.ii.p.2.

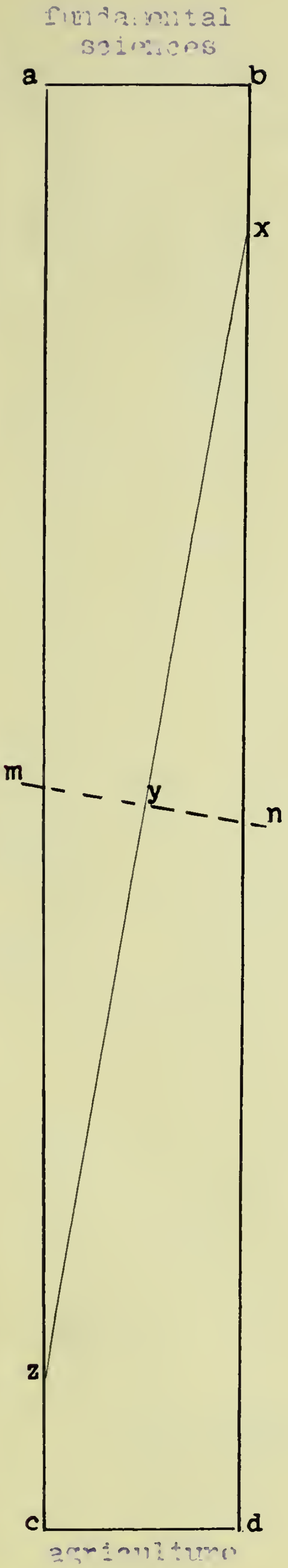

Fig. 1

III. Graphic Method of Treatment.

If, in the elongated rectangle $\overline{abcd}$ (figure 1.), there be arranged all of the subjects which may constitute a formal course in the combined science-agriculture group in order of their diminishing ratio of fundamental science to agriculture, starting at the top with sciences that have the least significance to agriculture and ending with the phase of agriculture that has the least relation to the fundamental sciences, they may be made to distribute themselves somewhat regularly from one end to the other. A diagonal drawn from a point x, near one end, to a point z, near the other end, may divide the rectangle so as to make it graphically represent the portions of the common area belonging to each subject and cut each into its two distinct portions, the area $\overline{abxz}$ representing the fundamental science and the area $\overline{cdxz}$ representing agriculture.

If the high school student wish to pursue a course having pure science as his goal will his course differ from that of the student whose course is agriculture? If so, where should each of them begin his

course to achieve his purpose?

Experience has shown that the average beginner in the high school is not prepared to appreciate unapplied science.[1] It is equally clear that the student of agriculture awaits instruction in the fundamental sciences before he can truly appreciate agriculture as a secondary school subject. Therefore, whichever end be the student's goal, the starting point should be somewhere near the middle of the rectangle as at y. If his goal be pure science his progress would be from $\overline{mn}$ to $\overline{ab}$ and he would necessarily have to omit or duplicate in his course that portion of his specialty $\overline{myz}$ which lies behind his starting point. Similarly, the student of agriculture proceeding from the same point toward the opposite end would omit or duplicate the portion $\overline{nyx}$. It is plain that if the two classes of students were united neither duplication nor omission would be necessary. And such union would insure what might otherwise be risked, namely, that the applied portion of the science work be truly practical and that the science work correlated with the agriculture be truly scientific.[2,3]

If, on the line $\overline{mn}$ (fig.1) which is perpendicular to $\overline{xz}$ at its middle point y, the rectangle be folded, the point x will fall on the point z and there will be an overlapping of the area $\overline{mnx}$ (fig.2.) which represents a saving of work, and results in mutual standardization of the science and the agricultural work. The sci-

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[1] Bagley: The Educative Process, p.232.
[2] Huxley: Science and Education, chap.vi. p.155.
[3] Bagley: The Educative Process, p.221.

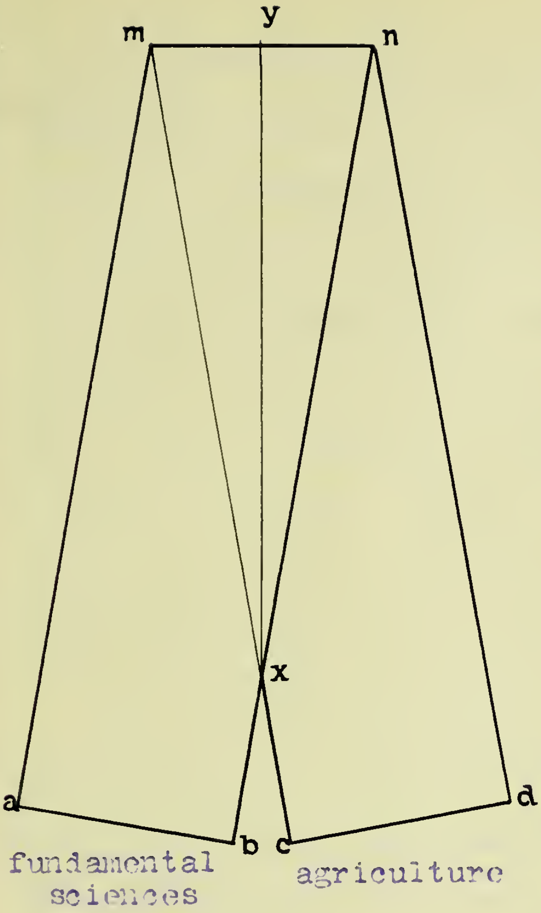

Fig. 2

ence work will all be on the left of the line $\overline{xy}$ and the agriculture still on the right side. Of the area $\overline{mnx}$, the left half $\overline{myx}$, represents the science work necessary for all of the agricultural work and the area $\overline{nyx}$ represents the agricultural work necessary as a proper complement in the understanding of the science, the area $\overline{abxm}$ represents science uncorrelated with agriculture, and the area $\overline{cdxn}$ represents agricultural work having no direct scientific dependence. If, for example, such a subject as "plants" be placed in the course near the middle it will cross four aeras, indicating that it is a subject of value to pure science, that it has a value to applied science, that its application is necessary to a certain extent in the teaching of pure science, and lastly, that much of the work with plants which the agriculturist must do is empirical and has no value for science.

The limiting of the teaching of science to that portion represented by the area $\overline{abxym}$, to which is believed to be due the fact that science has not succeeded so well as it should in the high school[1] is quite similar to the mistake of limiting the teach-

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[1] Davenport: Education for Efficiency, pp.145,146.

ing of agriculture to the portion represented by the area $\overline{cdnyx}$ which some propose to do.[1,2] The evident unity of this combined subject is too fundamental to be ignored though the point of bifurcation indicated by the point x,which marks a final election of vocation that may have had a much earlier inception,may require adjustment by experience before it can be located.Perhaps it will prove best to permanently regard it an unknown point in the prescribing of general courses. Below the point of divorcement agriculture must be its own science and the fundamental sciences must furnish their own activity and application.

The significance of the foregoing relationship to the purpose of the school is that the science student and the agricultural student should start at the same place,the line $\overline{mn}$,with the same character of work and gradually diverge,[3] the area of common interest growing smaller as they proceed and the uncorrelated portion of each course gradually enlarging until each half is free from any coordinate dependence on the other,though both are indirectly dependent upon a previous stock of common facts,principles,and experiences.[4]

Or,stated in educational terminology,the area $\overline{mnx}$ represents an identity of substance which it is good economy for the science teacher and the teacher of agriculture,who may well be identical, to enlarge and utilize.[5] And judging by the success of the teaching of pure science by means of applied science,the area has even a greater significance as representing an identity of procedure

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[1] Butler:Training for Vocation and for Avocation,Ed.Rev.Dec.1908

[2] Spencer:Education,chap.i.p.37.
Hall:Adolescence,vol.ii.pp.88-89. next page

[3] Davenport:Education for Efficiency,pp.6,11,32,35,55,57.

[4] Brown:The Making of our Middle Schools,p436.

[5] Eliot:Education for Efficiency,pp.46,47.

which can best be insured by a combination, in the same class, of students of science and of agriculture who happen to be working in this common field.[1,2] But the divergence graphically indicated as necessary for the attainment of the different goals, "science," and "agriculture" preclude any *identity of aim* after the student has proceeded so far as to have an aim.[3,4,8] In this respect the two subjects stand in the same relation as do any other two elective groups in the high school.[5,6] The idealization of each motive comes with the final uncorrelated portion.[7]

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[1] Gilbert: unpublished
[3] Ruediger: Principles of Education, p.115.
[2] De Garmo: Principles of Secondary Education, vol. i. pp.22,23.
[4] Brown: The Making of our Middle Schools, pp.5,457,459.
[5] Angell: Psychology, p.220.
[7] Bagley: The Educative Process, p.223.
[6] Davenport: Education for Efficiency, pp.14-17,45,48,65,124.
[8] Hall: See previous page

IV. Placing Sciences and Agriculture in the Scheme.

It has been attempted to show on good authority what is the proper place for each high school science in the course. These subjects when written into the rectangle abcd would distribute themselves as shown in the accompanying diagram (fig.3.), the progress being from the center upwards.

As the only difficulties in the study of agriculture are scientific difficulties, the correct fixing of the sciences indicates the order of presentation of the various phases of agriculture. The result is their distribution as shown in the lower half of the figure as determined after folding it. Although not of the most vital importance it is reassuring to note the logical sequence of subjects proceeding from the center downward.

But the logical order may be the worst order of presentation where relied upon in the instruction of those who cannot yet ha have acquired a comprehensive view of the whole field of science. Considering the matter of a gradual diminution of motor reaction essential to the learning process;previously referred to (page 15), it

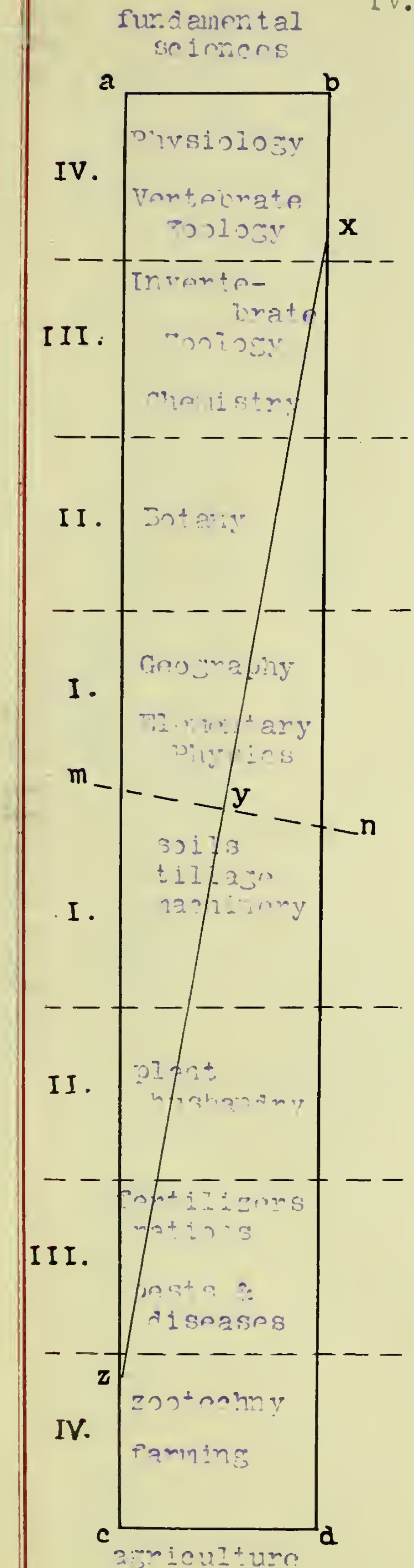

Fig. 3

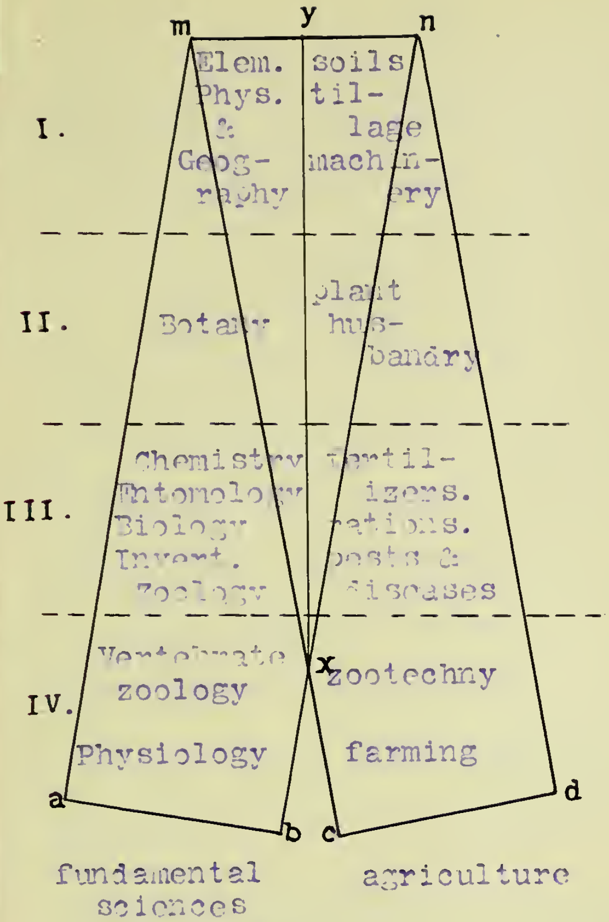

Fig. 4

is not a mere accident that the development shown in this sequence of agricultural topics agrees with that of the correlated sciences. It is believed that the close relationship between the agriculture and the sciences will safeguard the former where the latter are properly marshalled and the two correlated. Besides,the agriculture is by no means a new subject to the student if,as may be assumed,the grammar grades have presented the subject in a unified form and the student carries on, simultaneously with his high school work,the collateral extra-program activities which are the direct outcome and continuation of his grammar grade work.

All man-made rules of procedure applying to many individuals, including courses of study for schools,are compromises and to a certain extent forced. If the agriculturist object to the sciences being considered in fixing the order of presentation the answer is that their order was largely determined by the advantage to both interests of the utilization of applied science in teaching. The lack of agreement among agricultural schools upon an order of presentation argues that the subject possesses no pedagogical cohesion independent of principles common to both and which experience has largely worked out with regard to the one first in the

field - the sciences.[1,2] As a compound subject the sciences represent the portion whose formulation inclines toward psychological authority and agriculture that portion which is on the sociological side and hence less affected by pedagogical motives of formulation But if it be thought that the purposes of agriculture are to be subordinated to those of science the answer is that the salvation of the sciences to the high school course depends upon their being imbued with the economic motive and that the internal modifications which will come from the union will affect the sciences more than any which the latter may impose upon the agricultural work. The failure to recognize the unity of the two will be as disastrous to high school agriculture, as an educational subject, as it has been to the high school sciences.

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[1] Carlton: Education and Industrial Evolution, p. 208.
[2] Bailey: Training for Teachers of Agriculture, pp. 19-20.
Dewey: The School and Society, p. 107. used on page 72

V. Humanistic Science.

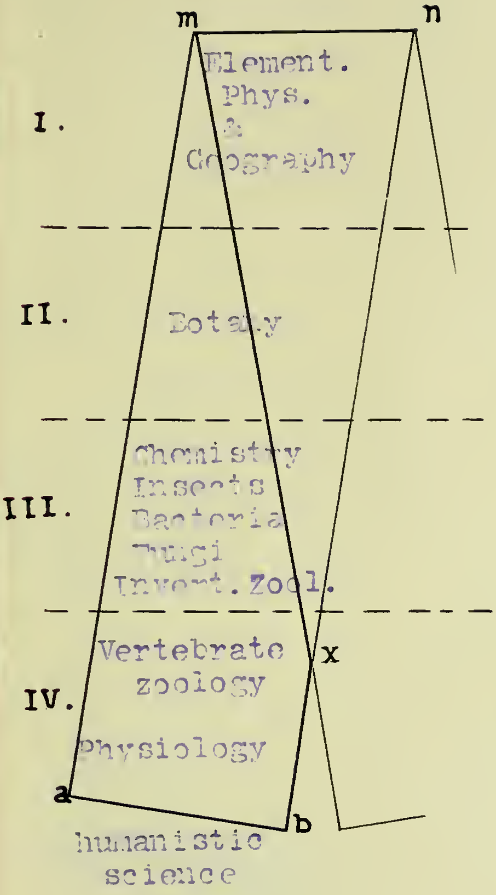

Fig. 5

The prime purpose of the sciences in the high school is not the training of scientific experts High school sciences may achieve more good for pure science by a training in ability to draw proper inferences from imperfect data and by inculcating an appreciation of the great hypotheses and discoveries in their historic perspective than by attempting to train for a scientific expertness that refuses to anticipate nature or recognize facts acquired empirically by "common sense."[1,2,3,4,5,6]

The necessity of the sciences to agriculture in furnishing interpretive principles which rationalize that vocation will not be considered here. Not less important, if indeed it can be treated separately in a general education, is the training in scientific method which is revolutionizing all realms of knowledge, including such widely divergent fields as history and education.[7] The result

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[1] Hall:Adolescence,vol.ii.p56.vol.i.p.185.
[2] Butler:Address of welcome to the American Association for the Advancement of Science,quoted in New York Independent,July 8,1900, p.85.
[3] Bailey:The Nature-Study Idea,pp.87,138.
[4] Huxley:Methods and Results,p.62.
[5] Dewey:The School and Society,p.60.
[6] Hall:The Ideal School,pp.484-488.
[7] Brown:The Making of our Middle Schools,p.445.

may be so much progress toward the long-hoped-for science of man which we call sociology. But the fundamental sciences may contribute more to sociology through the use of the agricultural materials with which, in the achievement of purely economic purposes, the student of the combined subject must deal. It is to this humanistic value of the fundamental sciences indicated by the area $\overline{abxm}$ (fig.5.) that attention is asked.[1]

To the devotee of "pure science" the association of a "chemically pure" scientific principle with agricultural materials may seem like a combination of the sublime with the ridiculous. But one should remember that "all 'goods' are disguised by the vulgarity of their concomitants in this work-a-day world; but woe to him who can only recognise them when he thinks them in their pure and abstract form."[2] Such association offers the only way in which our sciences can ever be made worth the doing in the high school. And without science we revert to an age when the intellect was governed solely by authority. Therefore it is worth considering how the sciences are to be made humanistic through the every-day medium of agriculture.

Geography "treats of the earth as the home of man." But the earth is not only the home of man but the source of his food. Through experiences in tillage only may one come to appreciate concretely the meaning of the term "Mother Earth;" while the exchange of products of distant regions cultivates the feeling of brotherhood and the interdependence of all races. A study of geographic influences on history shows that much that has been at-

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[1] Hall:Adolescence,pp.150-152.

[2] James:Psychology,vol.i.p.125.

tributed to human choice in the development of a race was really determined for them ages before by purely physical processes.

Through the study of the flower and its fertilization botany gives the most favorable opportunity for teaching in a cloaked form all of the science of sex,morbidity or ignorance concerning which during adolescence endangers not only the character of the individual but the virtue of the race.[1,2] The planting of a crop makes youth a partner with nature and civilizes by teaching him to submit with patience to nature's laws.[3] It makes a citizen of the nomad and is an original source of national stability.[4]

Chemistry trains in habits of honesty by requiring exactness and by its dependence upon the doctrines of indestructibility of matter and of correlation and conservation of energy. Properly idealized this subject may be as inspiring to sentiments of honesty and justice as may Emerson's "Compensation." Money is potential energy of which labor is the kinetic form. Its correct appreciation is a matter of great moral concern.[5] The individual who does not know the value of a dollar cannot safely be trusted with a dollar of his own or of other people's money.[6]

This is the beginning of an age of conservation. The natural wealth of forests and minerals is of slow accumulation and the permanency of industries depending upon such wealth requires that some system of reparation or control be practiced.[7] The burden of

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[1] Bagley:The Educative Process,p.348.
[2] Hall:Adolescence,vol.ii.p.210
[4] Blackstone:Commentaries,book ii.ch.i.
[3] Hodge:Nature Study and Life,pp.30-31.
[5] Carlton:Education and Industrial Evolution,pp.84,85.
[6] Hall:Adolescence,vol.i.p.409.
[7] Butler:Training for Vocation and for Avocation,Ed.Rev.Dec.1908 p.474.

instructing the coming generation in this matter will fall upon the agricultural work of the high school. Effect of the lack of conservation can be demonstrated best in any of the older agricultural communities in dollars and cents where failure to repay the loss to the soil due to the removal of crops results in diminishing yields. Such spoliation of natural wealth that belongs as much to future generations as to the present is a form of dishonesty that involves human happiness and national permanency. And ignorance of the law excuses no man. The matter wants idealization in the schools to make it truly humanistic.

The close relationship of disease, insanity, crime, and poverty make it necessary that the social reformer understand something of bacteria, protozoa, and fungi and parasitism generally.[/] The average jury in a criminal case, often made competent by their ignorance, are hopelessly "at sea" when the insanity plea is skilfully used by the defense. As a result murder is so common as to be known as our national crime. The nature of disease and practice in its control are afforded better instruction in the agricultural course than in any other because of the ease of estimating the effects of remedies, the ease of control, and the comparative cheapness of the materials involved.

In the unknown past when the human race elected to differ from other species by taking on a civilization it chose a course that often goes against instincts and developmental processes that have been perfected to a high degree by natural selection. These tendencies are still the inheritence of the race and make most of

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[/] Spencer: Education, ch. i. p. 58.

the problems which it is the duty of civilization to solve. The struggle of civilization is an up-hill struggle and must be repeated with each generation,hence schools. When sociological ideals weaken civilization lapses and the ever present biological factors destructive of racial achievement become more potent,for what man does not appreciate he destroys. Our greatest racial need might be expressed by the "ad," "Wanted,by tailless biped,a self-perpetuating civilization."

Biology is especially valuable for the developmental formulae which a study of the lower organisms teaches and which are interpretive of our sociological and political problems and tendencies. The prototypes of human instincts are found aming the lower organisms.Some far down the scale of animal life.[1] Whether these instincts are to be used or opposed in the interest of civilization does not affect the need of a knowledge of them on the part of the would-be reformer.

Beginning with the struggle for existence among plants,man's public duty as a partizan on the side of the useful and generous and against the weed may be made his first lesson in civic improvement. Nowhere can the law of natural selection be better illustrated than in the"field of the slothful." The student may also see that with the cultivated plant as with the cultivated race, were the law permitted to operate freely it would mean extinction or reversion with the loss of generations of patient improvement.

Here among agricultural plants and animals may also be found the best lessons of the effects of parasitism and symbiosis. The

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[1] Hall:Adolescence,vol.i.,p. 60-61 .

difficulty of the national government in finding the safe path between the struggle-for-existence policy of open competition and a policy of excessive protection is only the difficulty of striking the proper balance between governmental neglect and commercial parasitism. The ability to distinguish between symbiosis and parasitism, to one or the other of which conditions all men and all vocations are referrable, is necessary to youth who would select life work wisely.

When the student arrives at the point x where the separation and independence of the science work and the agricultural work occurs in the latter part of his course it remains to justify the science work on humanistic grounds alone. From this point economic agriculture has little to gain from correlation but the utility of agriculture in the teaching of the sciences will be noticed to the end.

Without some kind of specialization and division of labor the individual would have the same conditions of life to meet that Robinson Crusoe mastered on his lone island. Biology presents an analogue in the one-celled organism which must find means to satisfy all of its various vital needs and hence must keep functional all of the properties of protoplasm. The tendency of society towards specialization, whereby individuals and societies lose their undifferentiated character, is at the expense of the function of reproduction. Biology furnishes the analogue in hydra, one of the lowest forms which have special organs for different functions, a physiological division of labor that is shown to such a high degree in the digestive, circulatory, respiratory, sensory and other

organs of man. But the reproductive cells of hydra, it should be noted, come from the region of indifferent cells which retain all of the original properties of protoplasm. Similarly, society retains its germ plasm in the undifferentiated vocation of diversified agriculture. This source of national vitality has always been recognized by the great public leaders.

The natural tendency of government is toward the centralization of powers whereby the national government gains increased efficiency at the price of increased danger from bad government. Our union of states which were originally independent independent began with the attempt to jealously guard state government against the encroachment of national government. But by gradual development, as shown by court decisions concerning the implied powers of the national government, the doctrine of "states rights" gave place before the encroachments of the national policy and its latest form of territorial expansion until we now find the "ship of state" a long way from its original moorings. And the operation of a similar law appears in the business world in the formation of trusts.

Biology furnishes an analogy to this condition in the law of cephalization as exemplified by such arthropods as the earthworm, at one extreme, in which each somite possesses most of the vital functions of the individual, and the honey-bee, at the other extreme, built of similar somites from which there has been a migration of organs resulting in the formation of a so-called brain in the anterior end and other localized functions which it coordinates and directs, making possible a high degree of animal efficiency.

The important humanistic lesson of the foregoing example is that centralization is a natural process to which all creatures

are subject, that biology affords no example of decentralization, and that in recognizing that "eternal vigilance is the price of liberty" civilization acknowledges the difficulty of checking centralization at the best point for maintaining an efficient "government of the people, by the people, for the people."

Finally the law of evolution which frees the intellect from bondage[1] finds its most striking manifestation in the study of vertebrate structure leading up to the structure of man - the proper study of mankind. Thus approached there is established the kinship of all creatures and races. It also rationalizes the instinct to preserve racial integrity as tending to preserve all that the race has gained as it has struggled up from the world fauna through great tribulation. Through the work of the agriculturists in plant and animal breeding is being gathered data for the sociologist to use in the development of a science of eugenics and a philosophy of life.[2,3,4] And for that form of learning that relies on faith rather than investigation there is a hope that natural law may rationalize without destroying belief.

On the side of agriculture itself there are certain great humanistic values which may be mentioned in connection with those of humanistic science. If "will" be the ability to substitute remote for immediate good it is developed more in the production of a crop that requires months of patient labor for its acquisition than in working for an earlier or more definite reward.[5] And what

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[1] Bagley: The Educative Process, p. 124.
[2] O'Shea: Education as Adjustment, p. 70
[3] Hall: Adolescence, vol. ii. p. 230.
[4] Thorndike: Educational Psychology, p. 65.
[5] Bagley: The Educative Process, p. 103.

civilizing personal experience may more profitably be induced in a youth than a feeling of his value to society which comes to him from successful production of something which the world needs and approves by paying for it?[1]

These are the sociological questions that occupy the attention of the world as reflected in magazines and newspapers. While it is true that "the idea of conscious effort forever destroys the idea of making sociology a part of biological science,"[2] it is also true that "sociology presupposes psychology as psychology presupposes biology"[3] and that, therefore, biology is fundamental to sociology and is at the bottom of many of the problems which it is the purpose of sociology to solve. It is not recommended that all of these purposes of humanistic science be developed so far as here indicated but rather that the science teacher have this attitude and give the subject this trend. The unification of the whole subject of science and agriculture suggests the necessity of an agriculturally trained scientist or a liberally trained agriculturist to present it.

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[1] Davenport: Education for Efficiency, pp. 6, 11, 32.
[2] Blackmar: Elements of Sociology, p. 18.
[3] Giddings: Inductive Sociology, p7.

VI. Applied Science.

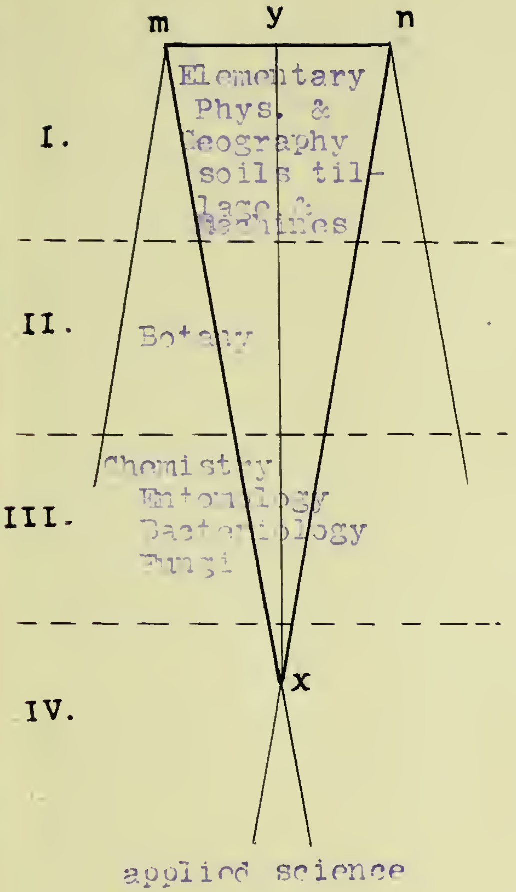

Fig.6

Considering the portion $\overline{mnx}$ (fig.6) in which the purposes of the sciences and of agriculture coincide.there is indicated a gradually diminishing correlation.Should the lines be projected in the other direction they would indicate what is actually true,namely,that below the first year of the high school the science work and the agricultural work are indistinguishable as to their limits.

Since the entire area $\overline{mnx}$ is regarded as a necessary part of both science and agriculture the line $\overline{xy}$ is in practice not very significant. In theory it means that the portion to the left is science necessary to agriculture and on the right,agricultural application necessary to the best teaching of the sciences. But since this area belongs as much to the one as to the other and because the sciences dictate its organization in the course it should pass as so much science in the giving of grades and credits. Generally speaking,biological sciences should be introduced through their economic examples while the physical sciences require,in their introductory stages,the elimination of all confusing factors and are best introduced as pure laboratory subjects

whence they should be carried to their economic application.

There is lack of agreement among school men as to what should be the nature of the first year science in the high school. Printed courses of study usually have the words "physical geography" or "physiography" in that position. But latterly there has been a disposition to call it simply "geography" and make it a peg on which to hang a variety of science instruction that, like geography, aims at giving an understanding of the larger phenomena of the individual and racial environment.[1,2,3,4] Any one of the views admits the propriety of correlation of certain portions of the subject with fundamental principles of agricultural physics.[5]

In the list of topics which follows there is a pairing of two correlated ideas, one representing the science and the other a phase of its application peculiar to agriculture and both necessary to the best presentation of the subject: specific gravity with soil analysis; hydraulics with drainage, irrigation, and erosion; capillarity with tillage; laws of gaseous bodies with weather phenomena; specific heat with soil temperature; simple machines with farm mechanics; physiography with crop production.[6]

In comparison with the other high school sciences it is geography of the first year is the one most often prescribed for all students. It's subject-matter is of such general value that it is regarded essential to any high school course and carrying it to a local application necessary for the best instructional results

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[1] Huxley: Science and Culture, ch. iv. p. 108
[2] Hall: Adolescence, vol. ii. p. 511
[3] Dewey: The School and Society, pp. 32-33
[4] National Education Association, "Proceedings," 1909, p. 820
[5] Carlton: Education and Industrial Evolution, p. 135
[6] Butler: Training for Vocation and for Avocation, Ed. Rev. Dec. 1909, pp. 473-474

necessarily includes a study of the soil. For the soil is the intermediate zone between the solids and liquids below and the gases above in which is a flux of matter that makes growth and plasticity of organisms possible. It is at the same time the region in which the heat of the sun,our only source of energy,ordinarily first becomes available for any purpose in the economy of nature. These two facts which give more than poetic significance to the term "Mother Earth" make the soil an essential subject in the introduction to all science work since it is nature's great laboratory and culture medium.

As indicated in the diagram botany is pretty evenly distributed across all four of the areas,signifying that the portion here under consideration constitutes a central half with the purely scientific lying on one side and the purely agricultural on the other. Botany is the natural basis of all plant husbandry,and habits of growth and fruiting habits are closely correlated with cultivation,propagation and pruning. The study of the structure of the kernel of corn and the conditions of germination and nutrition, and the agricultural matters of viability.plant food,and feeding habits are complementary and all involved with the chemistry of fertility and foods. The study of plant kinships as indicated by the floral organs has an economic value in enabling the farmer to intelligently guess the characteristics of the multitude of plants with which he may deal but which he may not have an opportunity to study singly. But the close relationship which it discovers between our worst weeds and our most valuable economic plants is very enlightening as to the possibilities of plant breeding. For it indicates that the value of cultivated plants is mainly the result

of artificial selection, an educational matter which heretofore pure botany has had no interest in. Only agricultural botany may give this educational value, hence the subject should be demonstrated mainly by its economic representatives.[1]

Chemistry, as indicated, has its greatest educational value outside the field of applied science. Its importance to agriculture is chiefly in connection with nutrition. With plants it is concerned with the round in nature of mineral plant foods, nitrogen, carbon, and water, as seen in plant metabolism. These are all factors of economic plant production without a knowledge of which agriculture is purely empirical. Besides the conservation of matter which such natural cycles imply in the case of plants, there is added in the case of animal nutrition the principle of conservation of energy. Thus it is that the value of an animal food is not alone in the chemical elements composing it, but is usually measured by its energy content on combustion. Here science rationalizes agricultural practice. But the debt of agriculture to the science of chemistry is pretty well repaid by the literature that economic experimentation has produced, so that it is neither possible nor desirable whether this common realm of applied chemistry is of greater significance to pure chemistry or to the subjects of fertility and rations, which demand a considerable independent treatment on the agricultural side.

The question of how far correlation of the sciences and agriculture continue has been somewhat arbitrarily fixed at a point near the beginning of the fourth year. Since correlation exhausts its educational value before it reaches its limit it is not prac-

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[1] Dewey: The School and Society, pp. 98-99.

ticable to carry it to its limit. Because of the fact that those portions of invertebrate zoology which have a value in an agricultural education are taken out and treated separately in the first half of the third year, attempts at correlation or a continuation of the applied field of science go no further than the middle of the third year. One unavoidable error peculiar to the graphic treatment is the relative amount of applied science indicated for the subjects of entomology and bacteriology which, being near the vanishing point, are very inadequately represented, the real intention being that there be little outside the "applied" area.

Here then a knowledge of the structures and life histories of insects, bacteria, and fungi, organisms which are a constant menace to the race, is regarded so essential to intelligent methods of repression or control that anything like purely agricultural or purely scientific lessons are not thought worthy of division of attention.[1]

Later portions of the sciences have an applied aspect which may be worth developing for "dual purposes" under the most favorable conditions but which under the average conditions contemplated here are best omitted. Although cross connections between the fundamental sciences and agriculture cease her it should be recognized that both portions still require all of the applied science that has preceded, and the agriculture, which is now ready to be erected into an independent science on its own foundation, the subject must always be written in the accurate terminology of pure science.

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[1] Hodge: Nature Study and Life, pp.18,19.

VII. Agriculture.

The matter of industrial education has been formulated much more rapidly in the case of non-agricultural vocations than in the case of the agricultural, because of its seemingly more urgent sociological necessity and its familiarity to the reformers. The result has been to promulgate as of general application a type of industrial education doubtlessly best suited to urban vocations but unsuited to agricultural. The difference between industrial education for the city and that for rural children is due to the vastly greater number of kinds of operations that come in diversified agriculture as compared with other pursuits, and the infrequency with which some of the most important of them recur. So it happens that the number of processes that are worth being made automatic by training is relatively small in an agricultural education suited to high school pupils.

A complete history of agriculture would probably show that so soon as manual operations became, through the division of labor, of sufficient importance and profit to be reduced to habit there has been a tendency to take them from that vocation and erect them into independent crafts, leaving with the farmer the numerous undifferentiated processes as they now exist. This distinction is fundamental in agricultural education, which is largely a training of judgment while all other forms of education for adolescents aim, to a great extent at the perfecting of habitual processes. This fact makes necessary a more constant dependence upon the underlying sciences in the case og agriculture.

Most of the diversified farm operations which demand skill

are best taught on the farm by the apprenticeship system. When phases of agriculture become highly specialized, such as horticulture and dairying which reach their perfection as suburban industries, the appropriate training becomes more like that for other industries. These, therefore, constitute most of that portion of agricultural practice that may be perfected by school practice.

The purpose is to divide economic agriculture as a high school subject into it's formal or program phase and an informal or extra-program collateral phase and to deal first with the former which is represented on the diagram by the area $\overline{cdnx}$ (fig.7). This formal portion is so distributed as to be correlated with the appropriate science.

#1. Formal Agriculture.

In the first year of the high school the work for agricultural students is not set off as a vocational subject because the portion of significance to agricultural students, the soil work and mechanics, is of such general value as to be necessary in demonstrating the subject to all students.[1] In addition to laboratory demonstrations all of this work in soils and mechanics, whether nature or man be the controlling factor, should be by field demonstrations.

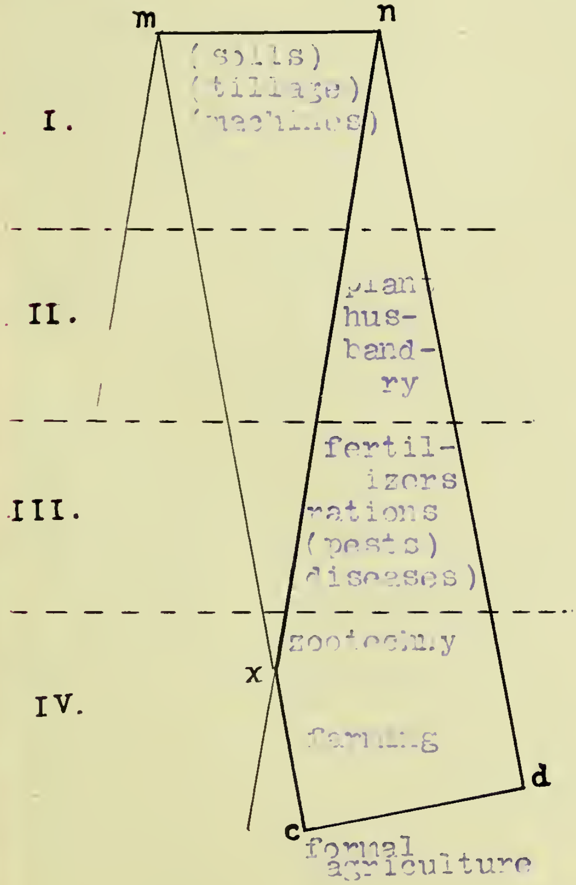

Fig.7

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[1] Dewey: The School and Society, p.32.

a. Plant Husbandry. In the second year correlated with the work in botany are those horticultural processes such as pruning and spraying, and all methods of propagation, that are worth perfecting as skills, as well as the judging of quality in all local plant products. Besides these there is a vast amount of purely informational matter that constitutes the lore of crop production and from which a limited number of the most important topics should be selected for study.

b. Fertilizers and Rations. The third year contains the most scientifically technical portions of the science of agriculture, namely, nutrition and disease, the latter of which is treated under the head of applied science. With these the desired end is not habit but knowledge of principles. Following the chemistry of this third year the vocational work deals mainly with fertilizers and animal rations. The work in entomology and bacteriology and methods of control has a science value that takes it out of the strictly vocational and makes it a matter of general education as previously noted.

c. Zootechny. "The vital knowledge, that by which we have grown as a nation to be what we are and which underlies our whole existence, is a knowledge that has got itself taught in nooks and corners; while the ordained agencies for teaching have been mumbling little else but dead formulas."[1] To no subject does this remark seem more pertinent than that of animal husbandry, a subject that has developed into a science with a lore of its own in the hands of men who had no knowledge of zoology.[2]

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[1] Spencer: Education, chap. i. p. 39

[2] Judd: Psychology, p. 357.

Animal conformation, though akin to vertebrate anatomy, will doubtless always be independent as a science because expertness in the one is not conditioned upon ability in the other, the one never suggests the other, and the two appeal to as different types of intellect as do the science of acoustics and the practice of music. Zootechny is put in the fourth year for the reason that it is a subject that cannot be completed and demands a final perfedting at the close of the agricultural course and because so far as it is knowledge it is empirically acquired and hence is not correlated with the fundamental sciences.[1] In this respect it differs from plant husbandry which is correlated with botany and lends itself to formal use.

Zootechny has no manual side that is practicable in the school. The subject as conceived for the fourth year high school class includes the history and description of breeds with a perfecting of the art of criticism. This is not the most important part of the subject. The fact that "the eye of the master fattens his cattle" cannot be demonstrated in a school, much less referred to a convenient place on a program.

Formal training in a fine art might properly be put into a high school curriculum in a fixed position such as is given this subject. But its absence from previous places in the formal course should not be taken to mean that it is to be omitted from all consideration until the prospective art student arrives at the place where formal training is given. The "art instinct" requires continuous cultivation and it would be a foolish teacher indeed, who would neglect the use of art materials and productions of galler-

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[1] Judd: Psychology, pp. 64-65.

ies or exhibits wherever found, for the purpose of study and criticism.

A similar attitude and method of treatment should be adopted with the art of animal criticism, and the opportunity for viewing and criticizing good and defective animals should frequently be provided throughout the grammar and high school course. These exercises from their nature must be extra-program, under which heading they will be found treated, and call for excursions to stock sales, fairs, feed-lots, and shipping yards. Only after such preparation will a formal course in breed histories and merits, and methods of improvement have their proper value with the student. This work in zootechny has for a prime purpose the development of ideals.

d. The Science of Agriculture. Agriculture has been called the oldest of the arts and the youngest of the sciences. To many, the idea of agriculture as a science in itself is confusing because of its close relation to certain fundamental sciences such as chemistry and botany. But something more and different is meant by "the science of agriculture" than the agricultural application of any or all of the fundamental sciences. As a science it may draw upon the latter for principles but like the science of medicine or the science of political economy its organization is its own and includes many details that do not concern the fundamental sciences.[1] This distinction is necessary in agricultural education.

In the teaching of any subject there should be distinct motives, perhaps a single motive peculiar to the subject which is always to be the criterion of methods of teaching it. But in the

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[1] Bagley: The Educative Process, p.182.

choice of a single motive every subject that may rightly claim a place in the school might insist that its ultimate single motive is racial good. In the choice of a second motive agriculture, like most others, might claim social or moral efficiency as its motive. But agriculture differs from the fundamental sciences in having a distinctly economic motive and it cannot attain its value as an independent subject unless the teacher is imbued with that motive. "It requires sympathetic relations with the natural sciences, as well as with the practice of agriculture." The present day plan for the classification of agricultural knowledge and its formulation into courses of instruction ....is based on the application of this knowledge in the natural divisions of agriculture, rather than on its scientific origin."[1]

Heretofore in this plan certain technical phases of agriculture have been referred each to its appropriate science with a conviction that where science is attempted it should be real science and not a makeshift.[2] And it was also with the understanding that high school sciences are soon to undergo a radical reform such as to make the approach to pure science by way of applied science to a much greater extent than has been the practice in the past. But it was also with a conviction that a science of agriculture could never grow out of such treatment, even were it possible to refer every detail of agriculture to a fundamental science for treatment. A strictly economic synthesis, though less refined than that of the fundamental sciences, is the only means of getting details properly proportioned, of insuring proper consideration of non-scientific

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[1] Editorial in Experiment Station Record, Jan. 1903. p. 402

[2] Davenport: Education for Efficiency, p. 103.

along with scientific factors, and of developing a unity which makes possible the inculcation of economic ideals. Lacking this point of view the scientist is incompetent to teach agriculture.[1,2,3]

"Mind begins with large wholes, passes from these to detailed parts, and then back again to the wholes - analysis followed by synthesis, differentiation followed by integration."[4] Throughout the grammar grades the unity of agriculture has been preserved so that each detail considered scientifically in the high school may be mentally incorporated into the whole as the work progresses.[5] This purpose is also aided by the collateral or extra-program work of the student.

But the agriculture of the student in the grammar grade is visible and local and limited by his capacity for science.[6] At the close of his high school course he is in need of a re-synthesis not only to teach a utilization of the more scientific phases of agriculture and a subordination of each detail to its proper proportion of attention but for the purpose of developing ideals and faith - "the substance of things hoped for and the evidence of things not seen." When this is accomplished such a student will then see in his environment not only what is visible but also what he hopes to make it, and this vision will sustain him through what, to the shorter visioned, may appear a very unpromising prospect. The planning of and working for improvements that are slow of realization, the planting of an orchard, the establishment of a crop

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[1] Heck: Mental Discipline and Educational Values, p.44,

[2] Bailey: Training for Teachers of Agriculture, p.13.

[3] Coulter and Patterson: Practical Nature Study, pp.22-23.

[4] Bagley: The Educative Process, p.232.

[5] Bailey: The Nature-Study Idea, p.37.

[6] Heck: Mental Discipline and Educational Values, p.138.

rotation, the founding of a herd, call for faith as well as wisdom and here in the last year comes the most difficult phase of agricultural instruction. And this development of the youth, impelling as it does toward citizenship, reestablishes the unity of the economic agriculture with the humanistic sciences and ends where all public education should end, in a preparation for efficient citizenship.

4c. Collateral or Extra-Program Agriculture.

A prominent characteristic of the present reform in education is its struggle against formalism. Whatever other desirable purposes may impel the reformer it is realized that a too rigid formulation will defeat those purposes and that freedom from formalism must precede all other purposes.[1,2,3,4]

One by one the different phases of science work and the different features of agriculture have been made to fit into the present familiar plan of high school organization until not only all of the scientific features have been disposed of but much that is peculiarly agricultural as well. There is still an indefinite remainder necessary to the subject but defying formulation, which cannot be prescribed in daily stints and hence not appearing in the daily program. This work, which is the natural continuation of the grammar grade agriculture, is the real vocational portion of the work and must be provided for at the pupils' homes.

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[1] Carlton: Education and Industrial Evolution, pp. 299-300.
Hall: Adolescence, vol. i. pp. 176-177. omit
[2] Dewey: The School and Society, p. 48.
[3] Warner: The Western Man, Scribner's Monthly, Vol. 20, p. 511.
[4] Spencer: Education, Chap. ii. pp. 89-90.

The vocational interest has its inception normally with the adolescent of the grammar grades. As the surest way to kill an instinct is to starve it in its nascent stages, the vocational interest should be provided with the proper exercise throughout the adolescent period.[1] This means, in the case of agriculture, the carrying to some economic application of the matter presented formally in the four years of the high school course. It should be planned for the purpose of providing an opportunity for the adolescent to cultivate and demonstrate his ability to carry over into vocational life principles learned in the school that apply to vocation. This carrying over requires combined mental and physical activities that can neither be divorced nor delegated.[2,3,4,5]

To one who insists upon a definite formulation of all school work this phase will not be attractive. But it should not be regarded a misfortune that this informal phase is necessary. And merely because other subjects have lent themselves more readily to a formulation apart from the youth's daily interests is not necessarily a merit but may be a defect. All studies should find some application in the life of the student and the fact that agriculture insists upon this application more than do other subjects gives it its superior sociological value. The teacher should realize that the neglect of this informal side of the subject endangers not this particular subject alone, but the whole present educational system. For there is "a handwriting on the wall" which

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[1] James: Psychology, vol. ii. pp.
[2] Bailey: Training for Teachers of Agriculture, pp. 47-48.
[3] Davenport: Education for Efficiency, pp. 4, 135.
[4] Heck: Mental Discipline and Educational Values, p. 120.
[5] De Garmo: Principles of Secondary Education, vol. i. pp. 183-184.
Dewey: The School and Society, p. 32. omit

reads destruction to a public education isolated from the real needs of the public. If education is to be reformed the reformation "should be in the hands of its friends." But once this gap is bridged by such subjects as agriculture and domestic science a way is provided for the passage of other subjects and a test for the evaluation of all subjects.

For one to attempt more than to suggest the nature of this collateral or extra-program work would be to incur to an equal degree the criticism here being made of the educational formalists but without such attempt it may be said that the work will fall under under the three heads here given.

a. Animal Husbandry. In a properly organized system of instruction the external points upon which depend the quality of farm animals will be mastered before the high school is reached so that the purpose of this work in the first years of the high school course will be to take advantage of such occasions as afford a chance to see new animals. The school should, therefore, be on the qui vive in all local movements of stock and such opportunities should be embraced even though they occasionly break into the formal instruction. Usually excursions will be required and the instructor can accomplish the greatest economy in carefully going over the ground before taking the class out.[1,2] The gradation of students by classes on such occasions is unwise as there is a positive advantage to lower classmen in the instructional "leakings" that come from the more advanced, while the undiscovered genius of

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[1] Indiana State Manual, 1904, p.
[2] Bagley: The Educative Process, p. 250.

the stockman among the former may be best stimulated when pitted against the superior learning which characterizes upper classmen.

Superficial criticism in stock judging may easily diminish in instructional value where not kept keen by some kind of exactness. As a check on this tendency a good deal may be done by the use of charts and bulletins designed to portray merit or its lack. Such drills at school by the class tend to the formation of uniform standards of perfection against which the animal when viewed is compared. It therefore follows that judging exercises are best preceded by a drill which shall make or revive the standard and that they should be followed at school by a mental review of the animal. This review is made effective by students' notes taken at the time of the viewing recorded on score cards or otherwise but especially by the drawing of animal details in outline. All that may be said concerning the value of drawing applies as forcefully in this undeveloped subject as elsewhere and drawing for its own sake could have no better exercise.

In the third and fourth years of the course the subjects of animal rations and the study of breeds call for informal consideration of those features by excursions. In addition to the foregoing treatment a large share of the undertakings treated later as "assumed services" and "home projects" contribute to the study of animal husbandry.

b. Assumed Services. The teaching of a science requires a greater or less amount of equipment for demonstration. This equipment constitutes the laboratory and apparatus which the school usually undertakes to provide. The teaching of agriculture in the

high school requires a somewhat similar equipment of which the school can at best provide only a limited amount. The reason relates partly to the expensive,miscellaneous,and cumbrous nature of such equipment,but more especially to the conditions of ownership and responsibility which attaches to the use of property. For many of the necessary articles of equipment involve permanent investments and permanent policies which the farm alone can provide. What this equipment should be may be largely determined by a consideration of the agriculture of the locality,for quite naturally the teachings of the school must include the interests of the locality.

The idea that the locality should depend for anything or in any way upon the school which it maintains may seem queer because of its rarity though it is a sad reflection upon an educational system from which the public has learned to expect no returns.[/] But the locality should be trained to expect certain practical services from the school,and since to do so would be to provide exactly the needs of the school for the demonstration of its agricultural instruction,the school may well assume certain extra-program services. Of those which may be carried to the school the most important will consist of the testing of milk and of seed, the budding of fruit, and the judging of the quality of products bought and sold in the neighborhood. With some encouragement this work may develop into a real service to the community and will be proportionately valuable to the school.

The excursion is a necessary feature of all correct science

[/] Dewey:The School and Society,p.97.

teaching but is especially necessary in all agricultural work for the many demonstrations that only the excursion affords. It may, as in science work be for observational purposes only. But some of the most important agricultural excursions will differ materially from the scientific in requiring that the students be not merely observers but also active factors.[1] They must take not only their eyes but their hands and should have a school outfit for doing such work as grafting, spraying, running levels, and emergency duties of indefinite character. The sociological value of such service should be apparent. As now practiced, the most frequent occasion for an excursion is afforded by athletics, and the usual public contempt of a high school athletic team toward such citizens and husbandry as come within their notice is an insult to industry and an odium which rightfully comes upon their school.[2]

The assumed services of the school call for the mastery of a limited stock of arbitrary practical recipes by the instructor, such that the unschooled observer may learn to apply. By this test more than by any other may the illiterate judge the success of the agricultural instruction. Such empirical knowledge will not be very highly regarded by the scientist, hence the danger of entrusting such work to him. And there is the danger of the other extreme in the excessive dependence upon them.[3] The intelligent layman will be ready to admit the probable merit of many things in the instruction which he does not care to investigate. The proper balance between theory and practice will be found somewhere intermediate between the recipe type and capacity of teacher and the

[1] Davenport: Education for Efficiency, p. 140.
[2] Brown: The making of our Middle Schools, p. 449.
[3] Bailey: Training for Teachers of Agriculture, p. 15.

scientist who fails to appreciate the necessity of "making good" in any of his instruction. Here as elsewhere in the agricultural work is the danger of neglecting quality for quantity.[1] [2]

c. Home Projects. To afford regular vocational practice throughout the year each student should undertake a project that requires daily attention, responsibility, and the application of some of his agricultural knowledge, and that demands and rewards manual labor, foresight, study, and devotion.[3] The student most favorably situated for this work will be the one who goes daily from his class work to his farm home where such duties as the care of a cow, an orchard, a herd of stock and various other activities suitable as projects have ordinarily been assigned him as his share of the domestic burden.[4] The project will be all the more valuable if it be something in which the student can match his ability against that of residents who are engaged in the same undertaking. He need not excel them in order to profit from the experience if he may be made to feel that he is getting a mastery of the matter which their experiences do not give them. The student who is not so favorably situated is at a disadvantage, but not so great as may seem. For in many cases it may be possible to assign such student as a partner in the same project as a companion whose home furnishes the equipment.[5] And the opportunities afforded by the average home in the towns and smaller cities or in the school garden

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[1] Bagley: The Educative Process, p. 165
[2] Davenport: Education for Efficiency, p. 168.
[3] Hall: Adolescence, vol. ii. p. 415.
[4] Davenport: Education for Efficiency, pp. 80-82.
[5] Davenport: Recent Aspects of the Nature-Study Movement, Nature Study Review, Dec. 1908

may be made fair substitutes. Finally, if other means are lacking there is often means of assigning appropriate manual training, with or without regular class instruction. The boy whose home and environment neither furnish furnish such opportunity will be rare.[1]

In the selection and launching of the project regard must be had for the prospect of continuing it to its logical end. A project may well be chosen in the freshman year that will continue to the close of the high school course. With the aid of the teacher in choosing, planning, and citing references for study of the subject, the project becomes a thesis in which maps, drawings, data, and curves of progress have a necessary place. With the completion of the thesis the student should have had a continuous training as a controlling agent in initiating, modifying, adapting and in actually doing the manual part of the work. The thesis thus becomes, in a measure, the record of the student's life for that period, an autobiography, to be placed on the shelves of the school library as a monument to his devotion and achievment, for the creation of economic traditions for the school, and possibly for its worth as a contribution to the kind of knowledge that is to ameliorate life's hardships.[2]

As the custom is well established of measuring in hours or credits all work counting toward graduation from the high school, due mainly to the accrediting system of the universities, it is usual for the high school faculty to bargain for students' work by offering credits for it. The artificiality of this system need not outweigh its utility and when the pupil has shown his ability

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[1] Carlton: Education and Industrial Evolution, p. 312.
[2] Dewey: Science as Subject-matter and as Method

to carry his project to a successful completion he should be entitled to credits therefor on the school records where such system obtains.[1]

The value of such projects as a preparatory work for higher education is unquestioned, though the accrediting system is a very inadequate means of vouching for it because the valuation must always be left with the instructor, without the accustomed means of checking his short-comings which influences the present attitude of the high school toward the university.[2,3] Whether or not the higher institution may come to trust his judgment does not seem so important when it is realized that such vocational experiences are absorbed into the informational phase thereby affecting the quality of the student's knowledge, and may thus, to a certain extent, come in for valuation with the formal agricultural work.[4,5,6,7,8,9,10,11,12] And besides, it should be presumed that the students have daily home duties for which the school has never given credit and that to rationalize such work by making it a project does not impair the student's chances of carrying the usual quota of formal work.[13] As between different students of the same school it is just and prop-

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[1] National Educational Association, Report of the Committee fof Ten on Secondary Schools, pp.17,52.
[2] Brown: The Making of our Middle Schools, p.378;442,443.
[3] Dewey: The School and Society, p.31.
[4] Baldwin: Mental Discipline, pp.138-140,165.
[5] Hall: Adolescence, vol.i.pp.132,173.
[6] King: Psychology of Child Development, pp.36-37.
[7] Bagley: The Educative Process, p.71.
[8] O'Shea: Dynamic Factors in Education, pp.27-28,29,30-32.
[9] Eliot: Education for Efficiency, p.38.
[10] Dewey: The School and Society, pp.24,121.
[11] Carlyle: Essay on Labor, p.185.
[12] Breese: Inhibition, Psych. Rev. Vol.3.p.58.
[13] Bailey: The Nature-Study Idea, p.85.

er that the project or some equivalent in domestic science or manual training be required of all students. The amount of credit should be estimated annually as to the practical lessons taught by the project but especially upon the economic success of the achievment as evidenced by the product and by the material difficulties overcome.[1,2]

The necessity for such vocational practice accompanying the study of agriculture was early foreseen and among the first schools the attempt was made to provide for it by including a school farm as a part of the plant. This method has not proven successful and has been generally abandoned. As this is the most perplexing phase of secondary school agriculture it is worth considering why the home farm is better. And the reasons are sociological as well as personal.

The instinct of property which becomes rational with adolescence cannot be properly cultivated under conditions which do not provide a real economic struggle for existence.[3] Ownership puts the student in the position of master of ways and means and makes the project really his own. The factor of profit which is involved intensifies interest and the desire for success.[4] Latitude in modification of the project may be entrusted to the student when he, rather than his teacher, is answerable to the critical public for its success. Where the student is given some freedom in the selection of his project he will come nearer selecting the one most

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[1] Davenport: Education for Efficiency, pp. 13, 28, 75.
[2] Carlton: Education and Industrial Evolution, pp. 91, 92.
[3] Bagley: The Educative Process, p. 198.
[4] Hall: Adolescence, vol. i. pp. 392-393.

appropriate to his needs if his undertaking is on his own farm.[1] As between the school and the community, where the latter is inclined to criticize, the student is on the side of the teacher whose help he has come to appreciate, and he does not feel that he has put off his obligation to defend the school when he leaves its precincts. He carries the school with him and must become its champion and when he meets unforeseen difficulties and the teacher can give relief the latter has him in the psychological condition essential to the most effective instruction.

Then the utilization of the home farm is the best possible means of accomplishing the sociological purpose of the school, though that purpose need not be patent to the community. The home connections form a bridge over which many other desirable things may pass from the school to the home.[2] It disseminates science to a wider influence. The student assumes the duty of converting his homestead to the best approved methods and of demonstrating them to parents and neighbors.[3] An evil which naturally results from the too ready formulation of subjects of instruction is that the school may become an institution quite independent and apart from the life of its patrons.[4] The school farm, whether so intended or not, certainlt resulted in further institutionalizing the school. It is opposed to one of the most desirable objects of the present movement - the decentralization of the school(not to be confused with the matter of consolidation). And decentralization is neces-

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[1] Davenport:Education for Efficiency,pp84-85

[2] Bailey:Training for Teachers of Agriculture,p.10.

[3] Bailey:The Nature-Study Idea,p.62.

[4] Dewey:The School and Society,pp.89,90,91.

sary for the student in order that his active individuality may come to the surface.[1] It is necessary in order that the public who pay for the school may get their money's worth; and the necessity of decentralization is a permanent one as a corrective of the natural tendency of education to grow obsolete.[2,3,4,5,6,7,8]

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[1] Carlton:Education and Industrial Evolution,p.205.
[2] Hall:Adolescence.vol.ii.p.412
[3] O'Shea:Education as Adjustment,pp.77-78.
[4] Angell:Psychology:p.320.
[5] Carlton:Education and Industrial Evolution,p.214.
[6] Bagley:The Educative Process,p.65.
[7] Dewey:The School and Society,pp.41,31,32,33.
[8] Davenport:Education for Efficiency,pp.35,50,51.

VIII. The Seasonal Requirement.

Before proceeding to the specific formulation of a course in the sciences and agriculture it is thought best to digress from the previous line of development long enough to take up another and quite independent factor that must be admitted to consideration in the making of a high school course in these subjects.

The agriculture of the past has, in America, been an agriculture of exploitation. The agriculture of the future will, it is hoped, be an agriculture of conservation. The difference between success and failure will, in the future, be largely due to a difference between knowledge and ignorance of agricultural science. But the future will continue to demonstrate what the past has demonstrated, that knowledge is no adequate substitute for "hustling." Doing is not so easy as knowing what is good to do.

J- R- worked hard all of his life, and, considering what he did to his farm, ended his career poorer than he began it. Somewhere early in life he lost a month and, although he never seemed to have lost any more, he could never make up the lost one, and so ran through on a delayed schedule one month behind the season from year to year. He cut his wheat too ripe; he delayed putting up his flood gate until his breachy hogs had torn down his wheat shocks; he did not get his shocks set up until his wheat had sprouted; he delayed threshing until after his fall plowing and seeding; he did not get his crop to market until rats had consumed his diminishing margin of profit. And so he drudged on from year to year for his board - his clothes were not worth mentioning. Can the school do

anything for this familiar type of farmer?

Punctuality is of the essence of success in everything and agricultural punctuality especially needs idealization hand in hand with the scientific instruction. The agricultural schedule of events differs locally, is variable from year to year, and not infrequently reverses its order. It also varies with the varying interests of a diversified farming such as is essential to the best rural citizenship. Plainly, therefore, it cannot be reduced beforehand to a fixed order of succession. And as the difference between successful and unsuccessful agriculture has been mainly, and will continue to be largely, a difference in promptness, any course of study that fails in any degree to emphasize promptness and conform to the local agricultural schedule, will to that extent be theoretical, will lack the support of the community, and will fail to induce the physical activities that must constitute half of the effort in high school agriculture.

The following instances are given to illustrate the fact that "there is a tide" in the presentation of each agricultural topic, which taken at its flood affects the agriculture of the locality, gives youth a much needed training in habits of punctuality, and may knit the school to the community in such a way as to enlist the most conservative in the cause of agricultural education; but neglected spells defeat in the school as it does failure on the farm. No attempt is made to enumerate the many events of the farm program. These examples pertain especially to the pedagogical schedule:-

Seed purity, viability, and control, as well as varietal merits, are subjects which, to affect the neighborhood practice,

should reach their climax at a time preceding the spring seeding sufficiently remote to give opportunity for the lesson to be demonstrated and appreciated, but near enough that it may affect the selection of seed. they may then be followed by a further demonstration on the school plots so that the test may be carried to completion in the crop.

Corn judging belongs to the fall and early winter, the period when every ear grown must be handled, and quality, yield, and price are uppermost in farmers' minds.

Feeds and rations are appropriate to the fall and winter when the efficiency of animals in the utilization of feed is the factor which largely determines whether crops shall be hauled to market (and the payment of the debt of fertility due the soil be deferred), or shall be fed on the land and only a finished product marketed. This is also the season of stock shows and sales and the time when domestic animals become amenable to the hand that feeds and shelters them. Stock judging of meat-producing animals comes here.

Dairying, of course comes in midwinter when fat metabolism is high and butter fat elaboration low; while poultry becomes rampant at the time when eggs are sold at fifty cents a dozen and there are none. "In the spring a young man's fancy lightly turns to thoughts of love." In the late winter, with equal truth if less poetry, the housewife's fancy very seriously turns to thoughts of poultry. And the first cackle announces the psychological moment for action by the teacher who would improve the next generation of spring chickens.

Weather is best taught in midwinter while the prevailing westerlies dominate and "highs" and "lows" and precipitation are influences less by local and more by general factors, forecasting is more accurate, and atmospheric movements may be illustrated by ventilation.

Agricultural literature, aside from the immediate needs of each subject as presented, belongs to the inclement season of winter with its lengthened evenings by the fireside, when the father has time to become interested in the school work of his children and "cracks of horses, ploughs, and kye," and "mixes a' wi' admonition due."

The study of fertilizers comes best immediately preceding their application, and fertilizer demonstration plots should be available to give a timely demonstration of their application and effects.

The effects of drainage, color, slope, texture, and depth upon soil temperature have little significance studied at any other season than early spring when seeding operations await the warming and drying of the soil. The lagging behind (hysteresis) in temperature of the deeper soil strata and the high specific heat of water and the cooling effect of its evaporation, whereby an undrained soil is always cold in the spring, the chief seeding season, make this the proper season for the study of soil temperature; while the factors affecting soil temperatures are confused in the fall, the effect of hysteresis being reversed.

Soil texture and implements of cultivation also belong

to the springtime.

Where cause and effect are to be studied or seasonal data are needed for later use a subject may become dominant at more than one distinct period.

Thus erosion should be presented in the fall when a generous field may be seeded with a well-earned winter's coat, and again in the early spring when the rains on a field lacking such coat gullies our hillsides and sends our wealth in muddy torrents toward the sea. At such times may also be taught the secret and irretrievable loss by leaching the soluble fertility which might have been locked up for future use in a winter cover crop.

Fruiting habits of trees and shrubs should be studied in the fall while fruit scars are easily identified and again in the late winter in connection with the principles of pruning which they govern.

Methods of drainage are best taught in the fall when the fields permit such operations and again in the spring when results of drainage and lack of drainage are most apparent.

The making of a mulch for the conservation of soil moisture is the chief purpose of spring and summer tillage,but the effect of a mulch can hardly be demonstrated in the field except in the fall after a summer drought which permits the drying out of the soil not protected by a mulch.

Plan courses as one will he cannot get around the fact that the law behind this requirement is too fundamental to be ignored in the high school. While the obligation is less binding on the

AGRICULTURAL CALENDAR FOR A HIGH SCHOOL (forty degrees north latitude), COVERING SEVERAL YEARS' WORK.

SEPTEMBER.	OCTOBER.	NOVEMBER.	DECEMBER.	JANUARY.	FEBRUARY.	MARCH.	APRIL.	MAY.	VACATION.
Field mulches.	Soil work in laboratory.			Weather.	Soils of the State.	Effects of slope, color, drainage and texture on temperature.			Precipitation record.
Erosion and drainage, field observations.				Role of humus.		Erosion and drainage.			
Identification of common plant families.					Leaching; cover crops.	Implements of cultivation; mulches.			
Legumes.			Pot cultures of wheat and legumes with soluble plant foods.			Legumes, manures and fertilizers.			
Seed gathering.	Wheat, oats and corn; quality and variety.			Destiny of crops.		Seed purity and viability.			
		Corn kernel, structure and composition.		Food principles; rations.	Corn belt; pop. and industries.			Corn breeding plots.	
	Fruits and fruiting habits.				Bulletin assignments.	Pruning, grafting, spraying.		School garden and demonstration plots.	
Insects; systematic and economic.			Judging fat stock.						
			Horse; external points and defects.		Year book statistics.	Farm records.			
			Dairy and beef cows compared. Meat and Milk.		State experiment station work.	Contour, soil, equipment, crops and rotations of local farms.			
		Breeds and care of stock.			Poultry.				

agricultural college it is probably more imperative on the elementary school. It bears a direct relationship to the interests of the locality and can hardly be emphasized too strongly. One who has felt this seasonal dictation throughout the yeard of his youth can never get past the feeling at certain seasons that he is someway shirking if he is not taking a man's place in the field. And it may be this combined discipline in promptness and patience that has made the farm such a valuable nidus for "captains of industry."

It is not surprising to discover that the seasonal order best suited to agriculture is at the same time the best order for the science work. For the sciences, its observance secures by appropriate motor reaction the educational values peculiar to the subject. For agriculture, it insures the teaching not only of what is teachable but of what is worth while as well. The effect of observing the seasonal order and of carrying collateral work is to keep the subject in a flux.[1,2] While this is opposed to rigid organization it is necessary in order to make the subject of value in vocational training.

A high school course of study that goes contrary to this necessity where it might follow it is pedagogical folly and invites failure. But the advantage of obeying this authority is commensurate with the danger of ignoring it, so that we have here not only a risk that no other subject entails but an opportunity for success that is denied all others. While its great value is in the development in the youth of the rare talent of punctuality, the

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[1] Hodge: Nature Study and Life, p.25.
[2] Dewey: The School and Society, p.40.

opportunity it gives the teacher to popularize a subject that may locally be on trial for its life is a feature not to be ignored. If the special activity that compels a hasty farm breakfast by lamplight happens to be the one dominant in the agricultural class and these school and farm schedules correspond pretty closely throughout the term, little matters it if the teacher limp a little pedagogically, or be slightly short on science. He has set into activity forces that cannot go wrong. Therefore a requisite for the teaching of agriculture in the high school is that the class catch the step even though it can do little more than mark time in the march of seasons.

IX. The High School Course of Study.

The making of his ideal course of study is the school man's way of building his air castle. At its worst it is a harmless pursuit and it may be the most concise and convenient way of giving a synopsis of an entire pedagogical creed.

But "the nemesis of all reformers is finality"[1] and the best course of study has defects when reduced to print. First of all, a course of study to meet the demands of modern life must be frequently readjusted. Yet when the ink gets dry the most carefully prepared course becomes fixed, and successful means of establishing it result in fixing it more rigidly. Again, any course fof study, however perfect, is deficient in that its author cannot accompany it to its application. Its meaning may be clear enough in his mind but when another attempts to breathe into his printed formula the breath of life it may sometimes become a Frankenstein in the hands of one who is honestly trying to follow its details. The greatest difficulty in the establishment of a ready-made course of study is not in preparing the outline but in making it mean to a second person what the author intends that it shall and this difficulty may be increased rather than overcome by minute elaboration. The course accompanying this discussion is offered with a full knowledge of these difficulties.

An agricultural course not simply to promote economic production but conducing to good citizenship is the ideal.[2,3,4] But since

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[1] Huxley: Science and Culture, ch. vi.
[2] Hodge: Nature Study and Life, p12.
[3] Carlton: Education and Industrial Evolution, p.313.
[4] Davenport: Education for Efficiency, p.103.

in this industrial age the first requisite of agriculture is that it be made profitable (else there will be no agriculturists), no course can achieve the ultimate purpose of agricultural education that cannot be made to insure economic success when once in operation.[1] And the ideal also contemplates a course suited to any good public high school supported and patronized by an agricultural constituency, and which must offer all the training it can for future citizenship or as a preparation for the university or for service as teacher in the rural school.[2]

If the previous discussion have not prepared the reader to interpret this course no discussion at this place will. It should be noted that the arrangement bears a resemblance to the graphic representation of the formal work in the sciences and agriculture. Attention is also directed to the attempted seasonal sequence of sub-topics. The arrangement in two parallel columns is to signify that the progress of correlated subjects is to be by presenting them in turn by some plan of alternation within each week in order that there be not too much divorcement in time between principles and their application. But not all of theory or all of the practise intended will be found in either column. It should also be noted that wherever in this course formal agriculture is prescribed, alternatives in domestic science and manual or technical training is allowed for.

These topics in formal agriculture are unelaborated, it being thought proper that the State work out a local seasonal schedule

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[1] Davenport: Education for Efficiency, p.150.
[2] De Garmo: Principles of Secondary Education, vol.i. pp.176-178.

A High School Course in Agriculture and the Sciences.

1

I. *Elementary Physics* and *Geography*.

Mechanics of liquids. (ocean)
Matter, force, gravity.
Mechanics of gases; (atmosphere)
barometer. Heat; thermometer.
Meteorology.
Earth structure; minerals. (land
Weathering; erosion. forms)
Principles of machines.

2

Moisture control in the field.
Soils; laboratory and local.
Daily weather map.
Soils of the State and physiographic regions of U.S.; climate and agricultural products.
Soil temperature and texture; methods of control.

3

II. *Botany*.

Structure and function of flower; science of sex.
Recognition of chief economic families.
Fruit and fruiting habits.
Gross and minute structure and function of root, stem, and leaf.
Plant physiology.
Seed structure, composition, and germination. (economic)

4

II. *Industrial*.

Ag. Horticulture and field crops.

Dom. *Sci*. ______

Manual *Training*. ______

5

III. (a) *Chemistry*. (first half year)

General chemistry; text, theory, and laboratory.

6

Industrial. (second half)
Ag. Foods and fertilizers.
Dom. *Sci*. ______
Manual *Training* & *Technical*. ______

7

III. (b) *Biology*. (first half)

Insects; ecology, life history, injury, structure, repression, collection, classification.
Fungi, bacteria, and protozoa; germ diseases of plants and animals, repression. Useful forms; inoculation.

8 *Invertebrate* *Zoology*. (second half)
Cell structure and division.
Additional invertebrate types.
Humanistic zoology.
Systematic zoology.

9

IV. *Vertebrate* *Zool*. & *Physiology*.

Animal tissues.
Skeleton and musculature of man.
Dissection of type vertebrates.
Nerves and sense organs.
Comparative anatomy and evolution.
Variation and selection.
Racial welfare.

10

IV. *Vocational*.

Ag. Animal husbandry & farming.

Dom. *Sci*. ______

Technical. ______

	Required	Recommended	Elective	total years
Ag.	1,2,3,(4),5,(6),7,(10).	8,9.	__	4 1-2
Dom. *Sci*.	1,2,3,(4),5,(6),7,(10).	8,9.	__	4 1-2
Man. & *Tech*.	1,2,3,(4),5,(6),(10).	7.	8,9.	4 1-2
Gen. *Sci*.	1,2,3,5,(6),7,8,9.	(4).	(10).	4 1-2

similar to the one given in the previous chapter and covering all of the agricultural principles mentioned there.[1] But while it is true that the work should have a local attachment it is not presumed that it will vary so much for different states as is popularly supposed. Local variation of principles and local variation in their application are two quite different things. Agricultural principles are general but the means of demonstrating them are locally variable. The high school agriculture will differ from the elementary agriculture in that the latter lays less stress upon the general and more upon the local. So it is that a high school course in formal agriculture, omitting suburban forms which specialize in restricted fields, may be prescribed for an entire state and it is believed that fifteen percent of variation for climatic differences is an ample allowance to make at the close of a course suited to all of the states.

After considering the reasons for the arrangement of this course, as previously discussed, the teacher who is desirous of conforming to it but whose school is not prepared to accept it in its entirety may be shown how it can be modified with a view to later complete adoption so that the advantage of state or national uniformity in the transfer of students may be secured from the start.

The plan here given is offered as the ideal toward which all schools may strive. As with other subjects found in secondary schools, this subject enters the course at its upper end being carried down as others have from the colleges.[2] And this crowding

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[1] Bailey: Training for Teachers of Agriculture, pp. 11, 12, 13.
[2] Davenport: Education for Efficiency, p. 139.

downward toward the elementary school will have to continue some time before the secondary school will be doing only secondary agriculture. This suggests that it may be expedient in the weaker high schools that the work in agriculture temporarily retain the form best suited to the grammar grades. Had an attempt been made herein to develop the grammar grade work it would have been guided by economic motives and the course based on local agriculture and the leaks through which the farmer's losses occur, with drill in most of the habitual processes that may come anywhere in the course in connection with horticulture, dairying, tillage, and repression of pests and diseases and with productive vocational experiences suited to the grade, all presented in their seasonal order and strongly developed on the extra-program side. The text book, though very unsatisfactory as a basis of presentation, may have a place in such instruction. Its danger is not alone in its being made the sole source of information but in the temptation to make it the course of study as well.[1,2,3,4,5] It is doubtful whether such modified course may safely be accepted as secondary in the transfer of credits without careful inspection.

For the school that is prepared to do two years of good secondary school work the first two years of the accompanying high school course are recommended. Where the school wishes to alternate these two years' work and combine first year pupils and second year pupils in the same class, a third year's work may be done, the corre-

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[1] Bagley: The Educative Process, p.363.
[2] Spencer: Education, ch. i. pp. 46-47.
[3] Bailey: The Nature-Study Idea, p.63.
[4] Hodge: Nature Study and Life, p.22.
[5] Dewey: The School and Society, p.100.

lated science work in each case being alternated with the agriculture as provided in the complete course. For any school that can do three years' work it is recommended that the third year of the course herein presented be omitted but that some empirical form of instruction in repression of insects and diseases and in fertilizers and rations be combined with the work of the fourth year of the complete course which may then constitute the third and last year of the modified course. With the two year course no re-synthesis is advised and whatever else of the third and fourth years is desirable may be developed in the collateral work of the class. In all cases where the third year is omitted, pupils transferred from a school having the modified course to a school having the full course should do the third year of the latter course. But the re-synthesis given in the three year course, if properly done, should be sufficient for transfer to any other school.

X. The School and Society.

The relation of the school to society is a theme that is occupying much attention recently in American education.[1,2] It is pertinent to call attention to the significance of agriculture in the schools as affecting the question. Reference is made to the accompanying figure which comprehends all that has been treated herein up to this point.

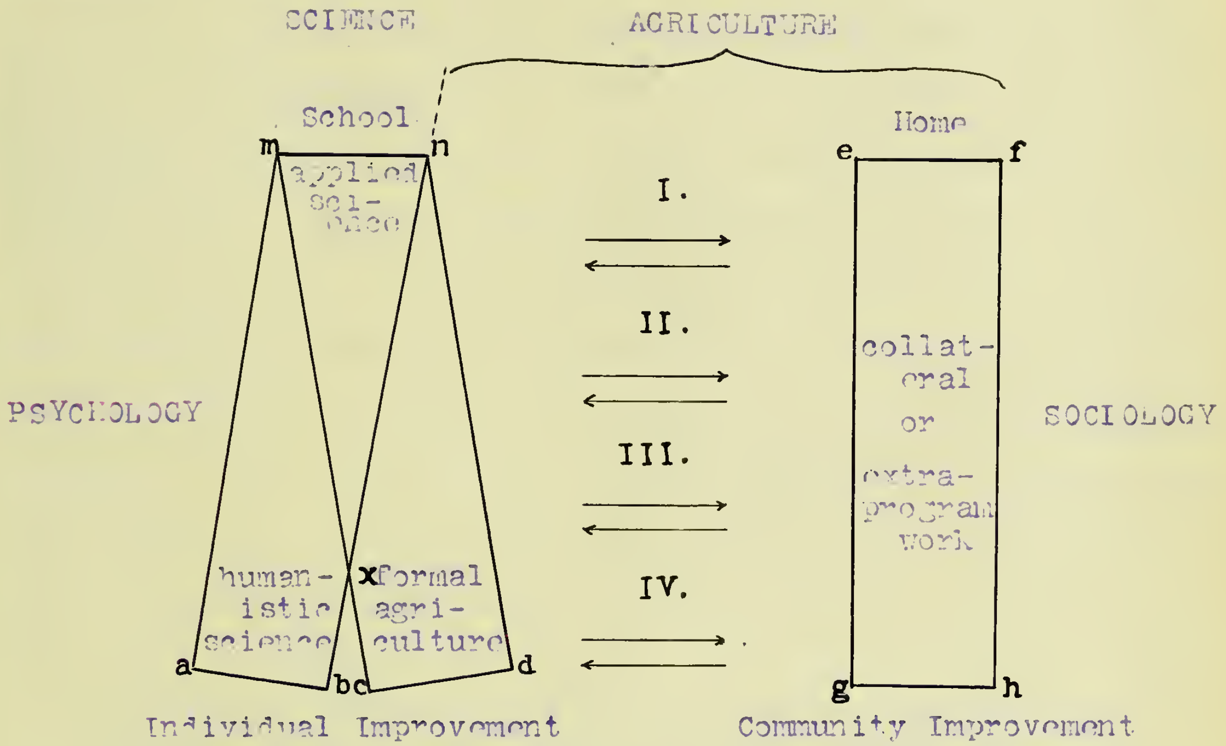

Fig.8

The familiar portion $\overline{abmnd}$ with its three distinct areas constitutes the portion of the combined sciences and agriculture which, with their common bond of applied science, may be called the formal side of the subject and is readily adjusted to school courses and programs. The collateral work is shown by the area $\overline{efgh}$

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[1] Dewey: The School and Society.

[2] O'Shea: Education as Adjustment, pp.35-38.

which lies on the side of the home and community. The relation between these various phases is such that passing from the left to the right they become less psychological and more sociological, less scientific and more practical, less formal and more free, less universal and more specific. It therefore follows that the formulation of the sciences will be largely on their psychological side while the character of the agriculture will be governed by sociological considerations.[1]

This polarity which a divided system of schools based on cultural and practical ideals would break is essential in the proper education of every child,[2] not alone because of the wide lateral range it affords youths of varying but undiscovered tastes[3] but because of the necessity that each individual know the pleasures of both learning and usefulness.[4,5] This polarity does not necessarily imply an assorting of branches of study but a proper development of each subject for its best teaching.[6,7,8,9,10,11,12] The scholar can never overcome his traditional helplessness until the training which perfects his scholarship provides it an appropriate applica-

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- Heck: Mental Discipline and Educational Values, p.117. carried to p73

[1] Carlton: Education and Industrial Evolution, pp.82, 83, 312.

- Judd: Psychology, p.71. see p 53

[3] Brown: The Making of our Middle Schools, p.455.

[4] Pestalozzi: How Gertrude Teaches her Children, letter xiii. p.270

[6] Eliot: quoted in Educational Review, p.124.

[7] Dewey: The School and Society, pp.42, 46, 58, 79, 86, 90, 127.

[5] James: Psychology, vol.i. p.125.

[8] Hall: Adolescence, vol.i. pp.234-235.

[2] Davenport: Education for Efficiency, pp.29-30, 35-36, 46.

[9] Bailey: Training for Teachers of Agriculture, pp.10, 15.

[11] O'Shea: Dynamic Factors in Education, pp.26-27.

- Carlton: Education and Industrial Evolution, pp.21-22. see p 54
- De Garmo: Principles of Secondary Education, pp.163-164. see p 15
- Heck: Mental Discipline and Educational Values, p.44. carried to p 73

[12] Eliot: Education for Efficiency, pp.37, .

- Bryan and Harter: Studies on the Telegraphic Language, Psych. Rev. vol. vi. p.345. carried to P 73

[10] Dewey: The School and Society, p.107

tion.[1,2,3] And labor will have no dignity until it have the enlightenment of science.[4]

Agriculture from its nature will contribute less to the education of the sensory-intellectual type of mind than to the intellectual-motor type and in doing so will aid education in righting its greatest mistake.[5,6,7] But it is a mistake to regard this type of intellect as of a lower order than the former, or to attempt to use the subject as an equalizer of the talents of children differing greatly in natural gifts. As a safeguard that the intellectual-motor type of mind be not neglected as it has formerly been in the schools, the teacher should be careful that the collateral vocational and manual side of the work be not slighted for those portions that are cared for under the head of the sciences.[8]

It is interesting to note that the progress made in the realization of the value of the sciences may be accurately stated in terms of the foregoing scheme of development. After a quarter of a century's experience, teachers of science are beginning to realize that it must be made humanistic if it is to affect youths' characters and that it is best taught in the high school for all purposes through its applications. And such high schools as have introduced courses in agriculture will not have them properly and permanently adjusted until their relation both to the science work and to the community are established. In fact most of the current

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[3] Davenport: Recent Aspects of the Nature-Study Movement. Nature Study Review, Dec. 1908

[5] Carlton: Education and Industrial Evolution, pp. 83, 84.

[6] Huxley: Science and Culture, chap. v. p. 130.

[8] Bagley: The Educative Process, p. 303

[7] De Garmo: Principles of Secondary Education, vol. i. pp. 20-21.

[4] Carlyle: Sartor Resartus, Helotage, p. 203.

[1] Bryan and Harter: Studies in Telegraphic Language, Psych. Rev. vol. VI p345

[2] Heck, Mental Discipline and Educational Values, pp. 44, 113.

conceptions on this subject fall into one or another of three classes, one having formal agriculture unrelated on either side, the second connecting the subject of formal agriculture to the community without giving it any proper scientific relation, and the third developing the relation of the sciences and agriculture but leaving the latter entirely formal and unrelated to local activities. And it may be well to note that making the subject a laboratory subject is not making it informal even though the neighborhood farms be made the laboratory. Only such experiences as we have classed as projects can ensure the breaking down of the enslaving formalism.[1]

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[1] Dewey: The School and Society, p.43.

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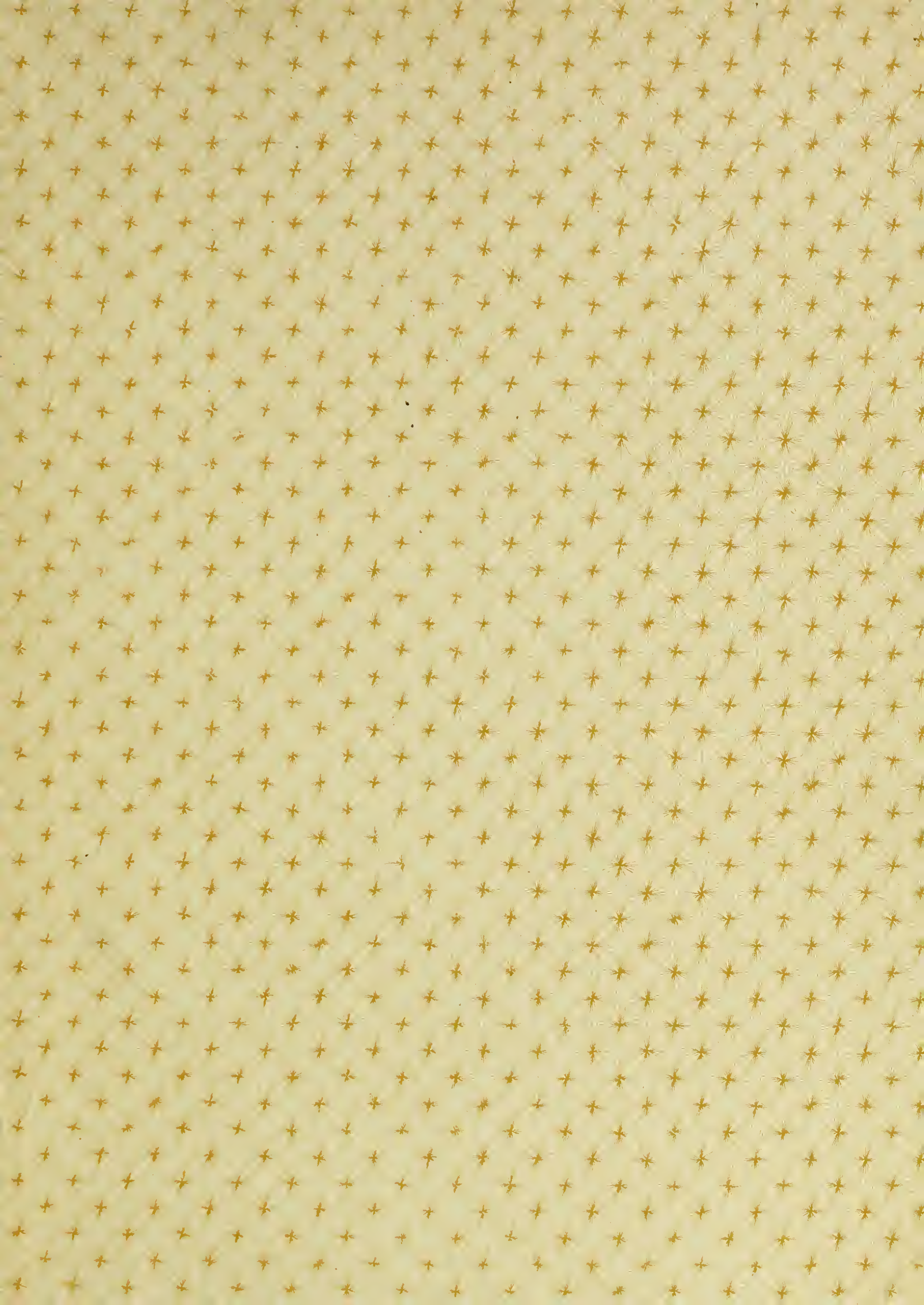

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